THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
Wiring Rules and Supply Regulations	509
Municipal Telephones	510
Electric Cabs and Charging Stations (*illustrated*)	511
Preston's Investigations on the Zeeman Effect (*illustrated*)	514
How to Design a Dynamo	515
Atmospheric Resistance to Trains	517
Röntgen Ray Theory	518
Modern Arc Lighting Plant	518
Reviews:—	
James Clerk Maxwell and Modern Physics	519
The Discharge of Electricity through Gases	519
Modern Switchboards	520
Correspondence:—	
"Some Motors and a Moral"	520
A Treatise on Ozone	520
The Institution of Electrical Engineers	520
Boosters	521
The Cost of Aluminium	521
The Position of Draughtsmen	521
Economy of Different Crank Angles in Steam Engines	522
The London County Council	523
Business Notices, &c.	523
Notes	530
City Notes	534
Traffic Receipts	534
Share List of Electrical Companies	535
Market Quotations	536
London United Tramways Tramway Schemes (*illustrated*)	537
Electrical Engineers' Specifications	538
Electrical Haulage in Mines	539
Technical Schools of Germany	539
Accumulator Traction	540
The British Association:—	
Hydrometers of Total Immersion	540
Electrical Traction by Surface Contacts (*illustrated*)	541
The Electro-Thermal Process for the Manufacture of Phosphorus	542
New Patents	543
Abstracts of Published Specifications	544

THE

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WIRING RULES AND SUPPLY REGULATIONS.

So long as the local plumber and gasfitter is able to dub himself "electrical engineer," and run wires for a confiding client without being called upon to serve some sort of apprenticeship to the craft, wiring rules are a necessary evil. The Board of Trade, in the interests of public safety, have set a minimum limit to the insulation of interior wiring, and if the best comes out below this, the "undertakers" are not allowed to supply. Indeed, on them is thrown a great deal of responsibility, for not only must they exercise all due precautions in delivering energy to a consumer's terminals so as to avoid risk of causing fires on the premises, but they are not compelled to give a supply of energy to any premises unless they are reasonably satisfied that the electric lines, fittings, and apparatus therein, are in good order and condition. As we pointed out at the time when the Board of Trade held the Conference in 1895 upon the Draft Regulations for Safety and Supply, it was anticipated that more definite powers would be given to companies and municipalities to deal with defective wiring, but it was found when the Regulations were finally issued that matters were left very much as they were.

Mr. Wordingham, in his paper on "The Control by Municipal Authorities of Consuming Devices and the Wiring Connecting them to the Mains" read at the Municipal Electrical Convention of 1896, expressed his opinion that a fully equipped standardising and testing department should be set up by the local authorities supplying electricity, and samples of material used in wiring should be submitted, in order that proper tests could be made to see that they were up to the required standard.

The Manchester Corporation, in an omnibus Act of 1897, had powers conferred upon it to make regulations in connection with its local supply, and the September, 1898, issue of the "Regulations as to the Supply of Electric Energy to be Observed by Consumers and Electrical Contractors," is now in force. In this issue the old regulations have been thoroughly revised, and a number of novel conditions added. We shall deal almost wholly with what is new. Most of the existing rules of companies and fire offices are intended to secure good work and reliable material. Croydon, for example, has a set of rules which are brief and combine with the technical points a summary of the general conditions of supply. Many engineers and station managers prefer to clear the wiring rules of conditions as between the suppliers and the supplied by relegating such matter to forms which are issued with the application for supply, or embodied therein; but in the Croydon rules, and in most others, the consumer is let down as lightly as possible, while the usual offender, the wiring contractor, is tied down to a certain class of work, which alone will be accepted. In the new Manchester rules we find, however, that *all* fittings, &c., must be approved in writing by the corporation engineer.

In other words, we have an attempt made to carry into practice the idea given in Mr. Wordingham's M.E.A. paper. This seems to us to be a step in rather a dangerous direction. It is a question whether it is altogether wise to worry consumers over every little detail of their installation, although the intention is obviously good. The danger lies in the fact that, notwithstanding disclaimers of responsibility, the consumer will mentally rely and believe that if everything upon his premises has received "approval" as is required by the letter of the regulations, then he is perfectly safe. He will be much distressed if from another point of view his fire office inspector requires an alteration or addition! We need hardly state the inevitable result upon the mind of the average non-technical man, who is liable to forget that even doctors differ. Regulations may certainly be overdone, and to our mind only *special* apparatus should require special approval. All everyday fittings such as wires, fittings, switches, holders, &c., may be taken as passable, except and unless the inspector happens to be brought face to face with an unsatisfactory or badly-designed accessory, which is now the exception and not the rule. It is in the combination of reliable appliances that risk comes in, for which the wireman is solely to blame. Bad work with "approved" fittings is quite possible, and the risk will be little affected by the particular make of the fitting if the man who puts it up possesses thumbs instead of fingers, and is generally careless and irresponsible. To require a member of the public to fill up elaborate printed forms and obtain written approval to every detail of a small wiring job is, we cannot help thinking, unnecessary, and, perhaps, ill-advised. Mr. Wordingham, however, thinking differently evidently has the courage of his opinions.

A further point arises as to the relationship now created of local authorities to manufacturers of fittings. The old safe rule of ignoring the name of the manufacturer and dealing solely with the article before one, gives place to a direct interest in Messrs. So-and-so and their wares which will call for very prudent action on the part of subordinate officials. We neglect the obvious loss of time and increased work that must devolve upon everybody. The best test of the whole thing would be to sound the consumers in Manchester, say, 12 months hence. We can imagine that they will be of opinion that electric lighting is a very complicated and dangerous business if all this procedure is essential, and may even in their mind of minds wonder if a few lamps could not be put up without the powers-that-be taking such a paternal interest in what they use. When 220-volt lamps first began to be used, we know that many an engineer regarded the stiff rules as to wiring as an imposition upon the public, the general impression being that if such extreme precautions *were* necessary, then 220-volt supply was a thing to be dreaded and avoided by the public. To-day thousands of lamps are being wired, and good work, reliable work, is being done; but who insists upon what two or three years ago appeared in the then rules? After all, the consumer is the man to be regarded with favour, and while safety is, and must be purchased at all costs, there may be a tendency sometimes to exaggerate known difficulties, and take precautions which, while good in themselves, are not worth the price paid for them.

It is not necessary to run through all the Manchester rules in detail, but we will conclude by mentioning what is said about radiators, the term including ovens and cooking apparatus generally. The framework of each radiator must be earthed; by this we presume it is meant that an electric kettle must have a third wire leading to it, the other end of the wire being efficiently earthed somewhere. Again, radiators must stand on stone or incombustible material, be 20 inches away from combustible substances, and a clear space of 6 inches must be left between the bottom of the radiator and the stand. When we see an endless number of gas plates, ovens, ring burners, and other flame heated domestic appliances—to say nothing of the kitchen fire and shop gas jet—which do not comply with this stipulation, we are amazed to find how little we realised the dangers of electric heating as compared with time-honoured gas, and cannot but look more leniently upon the oft-repeated strictures of the gas journals respecting the risks attending the domestic use of electrical energy.

MUNICIPAL TELEPHONES.

The municipality of Glasgow has for some time past sought to obtain from the Postmaster-General a license to undertake telephone exchange work. Their efforts have hitherto been without avail, but, being pertinacious, and continuing their agitation, they have at length been so fortunate as to find that the policy of the political heads of the Department and their own wishes coincide. As recorded in our last issue, the Duke of Norfolk has decided to grant a license, subject to Parliamentary powers to act under it being obtained by the Corporation, and subject also to the termination of the license in 1911. The decision is of considerable importance.

There may be reasons why the Post Office should await the results of one experiment before granting other licenses; but, although Glasgow has a progressive Local Government, there are other municipalities who will certainly consider themselves as much entitled to pioneer a new undertaking, and there may even be some who feel that the success of municipal telephones is dependent on the experiment being tried in their own particular locality. Under any circumstances it will be difficult for the Postmaster-General to discriminate in the granting of licenses, and it may be supposed that eventually all who ask will receive. The first impulse of many municipalities will probably be to emulate Glasgow. Others may give the matter sufficient consideration to inquire what it is that Glasgow has acquired. Unless some changes are made in the conditions, Glasgow has acquired the right (presuming Parliament permits) to incur an unknown outlay in establishing a business of which it has had no experience, on terms which shall admit of no profit, and for a period in which it is impossible to recoup expenditure. And this branch of municipal enterprise is to be built up in competition with an existing business. The acquisition of a patent was once described as obtaining a right to spend money in litigation. There was a part of the Queen's dominions that was regarded as the grave of political reputations. No matter how successful a diplomatist had been elsewhere, some *contretemps* always awaited him in that quarter of the world. We are afraid that Glasgow has acquired the right to spend money without the possibility of adequate return, and that its reputation for municipal management may be entombed in its telephonic enterprise. We have so often touched on this subject that it is not necessary now to go into details. There is a general dissatisfaction with the telephone facilities at present afforded. If there were no other way out, the municipal competition might be welcomed; but since it is not the best solution, and, on the terms proposed, is certainly disadvantageous to a municipality, we can see little good in encouraging the conflict. Still, if the ratepayers, with their eyes open, are disposed to take the risk, we can but wish them success in their efforts, and hope for some unexpected advantage in the end.

ELECTRIC CABS AND CHARGING STATIONS.*

The construction of the most elaborately-equipped charging station for electric vehicles in the United States, and probably in the world, has just been completed in New York City. This work has been done by the Electric Vehicle Company, the successor of the Electric Carriage and Waggon Company, whose vehicles and station were described in the *Electrical World* of August 14th and 21st, 1897.† In these articles the vehicles themselves were fully described, so that but a brief mention of the essential points and the improvements over the older types is necessary here.

The Vehicles.

The original equipment of the old company was 12 hansom cabs and one brougham, while the new company is about to put into service 50 hansoms and the same number of broughams. The cabs are, as shown in the accompanying illustrations, fig. 1, four-wheelers, driven by motors geared to the forward wheels and supplied with current from the battery box, situated under the driver's seat back of the passengers' compartment. Their running gear is practically the same as that shown in the elevations of the brougham, fig. 2. Of the external and visible improvements over the old type one is an increase in the height of the hood, the older vehicles being so low as to have an unprepossessingly squatty appearance compared with horse-drawn cabs. A dashboard has been added to the front of the vehicle to improve its appearance, and to give the occupant a sense of security that was lacking with the open fronts of the former vehicle. Another change is the use of solid discs instead of spokes for the wheels. At first sight a return to first principles of the wheels of ancient Egypt is the impression given, but in reality quite an improvement is made, in that the wheel has a much less intricate surface, and is, therefore, more readily cleaned. The body of the wheel is composed of two steel discs $\frac{1}{16}$th of an inch in thickness, dished so as to give a maximum breadth at the hub, and a minimum at the periphery. The discs do not meet at the latter point, but are separated by a wooden rim, over which is a crescent-shaped steel rim to receive the tire, which is 5-inch single-tube pneumatic, the rubber walls of which are about three-quarters of an inch in thickness. All four of the wheels are 36 inches in diameter.

The batteries consist of 48 cells of chloride accumulators of the F. V. type. The plates are separated by perforated corrugated hard rubber sheets, the battery jars being of hard rubber, separated from each other by glass plates. Instead of mounting the cells, as was done in the older vehicles, in four separate trays, which could be removed independently, thus dividing the weight, so that they could be removed by hand, the batteries in the new vehicles are mounted in one substantial tray, consisting of an angle iron frame, lined with wood. This change is allowable on account of the power equipment described below for removing and replacing the batteries in the vehicles. The trays, instead of resting on rollers within the vehicles, slide in on angle iron guides, the battery chamber being entirely lined with lead and drained with gutters and spouts, so that any acid which may spill will not run out around the door or over the running gear and destroy the finish on the exterior of the vehicle. The battery equipment is somewhat heavier than that on the old vehicles, weighing as it does about 1,300 lbs.

The new controller, instead of being fitted with a reverse position, as was the case with the former controller, is fitted with a separate but interlocking reversing switch, so that the three speed positions apply to either forward or backward running. No magnetic blow-out is used with this controller, and each contact is made doubly certain by the use of two independent contact fingers in each division. See fig. 3. The speed variation is obtained by means of a division of the battery into two groups, which may be placed in series or multiple, the third or highest speed being obtained by a re-arrangement of the series field coils of the two motors from a series to a multiple combination. See fig. 4.

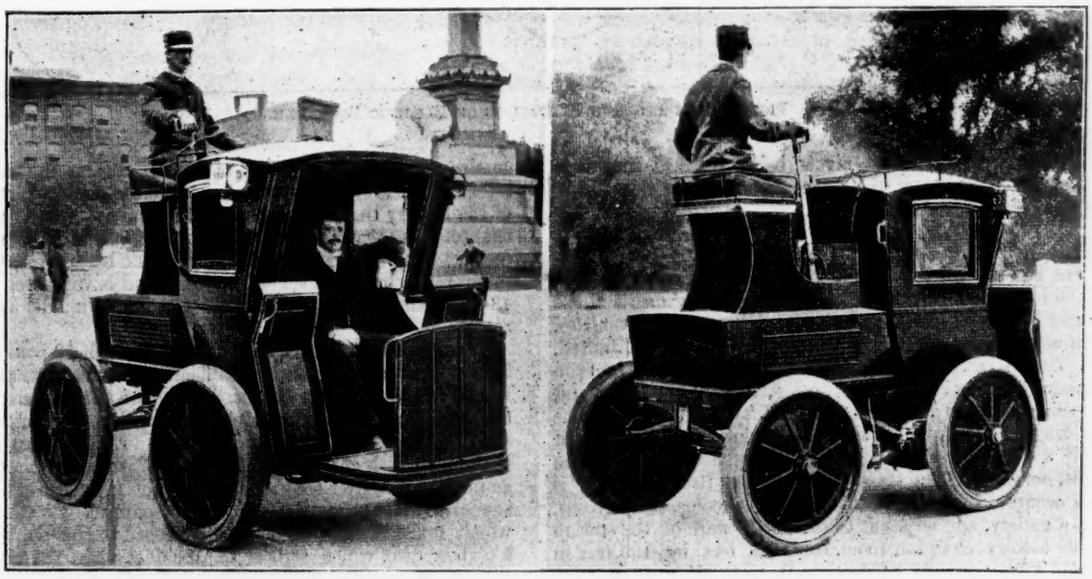


Fig. 1.—Two Views of the Hansom.

In the main circuit there is also what is called an emergency switch, in such a position that the driver can strike it with his heel and open the main circuit in case for any reason the controller becomes inoperative. The blade of the emergency switch is also removable, and can be taken out when the driver leaves the vehicle, rendering it impossible for any unauthorised person to set the carriage in motion. A special charging plug is also attached to the circuits, and is mounted in the battery chamber for charging the battery in place in the vehicle. This will prove useful when the battery is charged at points other than the main station described below, and several such points will be equipped with charging connections by the various direct-current supply companies in and about the Greater New York. One is already in service at Coney Island, and another is about to be put in service in the downtown part of New York City at the Duane Street station of the Edison Electric Illuminating Company.

The motors are four-polar, and are rated at 2 horse-power at about 700 revolutions per minute, this giving the vehicle a speed of 12 miles per hour. The pinion on the motor shaft engages directly with an annular gear mounted on the wheel disc, the two independent motors allowing for turning

* New York *Electrical World*.
† Electrical Review, September 3rd and 10th, 1897.

sharp corners without differential arrangements or serious strain. Braking is effected by means of brake shoes acting on wheels on the motor shafts. The steering gear is practically the same as on the older vehicles, the only difference being the removal of the pivots from within the wheel hubs into holes in the table legs keep them in place, although they are not bolted down in any way, and may, therefore, when rotted by the acid fumes, be readily picked up and removed by the crane serving the room. Mounted upon them are four simple U-shaped pivoted castings, the weight of the battery

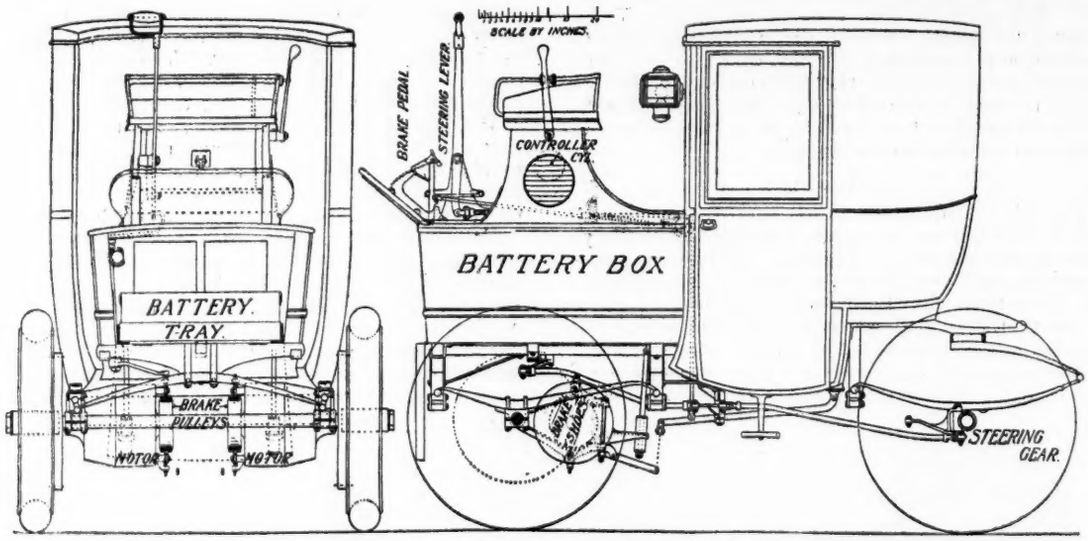


Fig. 2.—Side and End Elevations of Electric Brougham.

to a point just outside, the pivots being inclined somewhat so that the extension of their axes approaches the point of contact of the wheel and ground.

The Charging Station.

The new station is centrally located, and is, oddly enough, in the immediate neighbourhood of the establishments of the largest houses interested in horses and horse-drawn vehicles, such as the American Horse Exchange, Tattersalls, Limited, &c. The station, which is about 75 × 200 feet in size, fronts on Broadway at one end, and Seventh Avenue at the other, and is located between Fifty-second and Fifty-third Streets. The building consisted, before the vehicle company made use of it, of a single large room, undivided by floors or partition walls, covered with a trussed roof. The Broadway end is now occupied by a tier of offices, waiting rooms, stock rooms, and a gallery, and adjacent to the north wall of the station is the battery charging room, some 36 feet by 130 feet in size. This room is 11 feet in height, above it being a carriage storage room, supported on 25-inch steel girders. The latter is reached by two electric vehicle elevators. The charging room is filled with tables on which the batteries stand while receiving their charge. There is room for some 200 of these tables, about 150 being installed at present in

coming down on the short leg of the U, causing the contact attached to the longer leg to bear against the contact terminal of the battery tray. One pair of diagonal contacts is cross-connected, so that the two groups of cells (48 in number) are connected up in series for charging. The battery charging-room is enclosed except at its ends, and is ventilated by a 48-inch exhaust fan drawing air from the middle of the room.

The tables are supplied with current through 12 conductor lead-covered cables below the floor level, from what are known as the indicator boards. These are slate panels, each fitted with two pilot lamps, eight simple solenoidal ammeters, and eight four-position rotary switches. Each battery table is supplied with current through one of these switches and ammeters, the latter consisting simply of a vertical plunger, supported on a helical spring and surrounded by a solenoid, which tends to draw it down. Attached to the plunger is a carbon disc, which strikes one contact when the current reaches 50 amperes, this contact closing the circuit through the green pilot lamp. If the current falls below 10 amperes the disc rises to a point at which it strikes a contact, illuminating the red pilot lamp. In this way the lamps give positive visual indications, which can be seen from any part of the charging room, that one of the batteries attached to

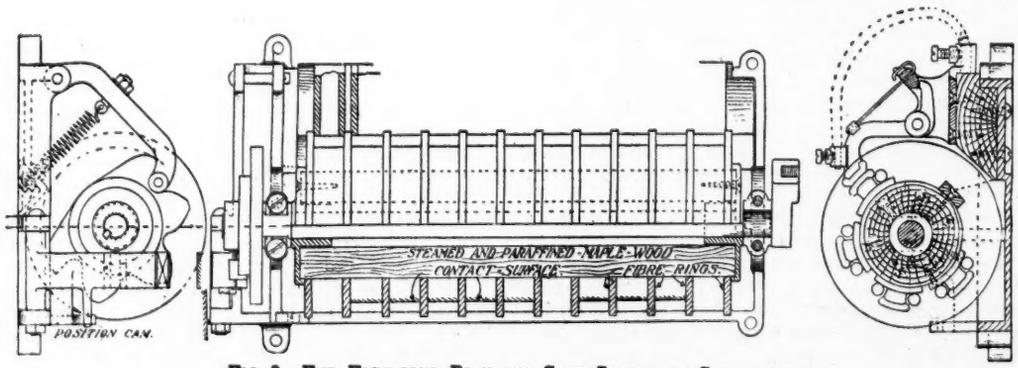


Fig. 3.—End Elevation, Plan and Cross-Section of Controller.

eight regular rows lengthwise of the room. The tables consist simply of strongly braced wooden structures put together with wooden dowel pins, no iron whatever being used in their construction, and painted black with P. and B. compound. Iron dowel pins projecting upwardly from the cement floor

that panel is receiving either an excessive charging current or one which should, to economise time, be increased. The current supplied to the batteries is adjusted by the four-position rotary switch, the four different positions connecting the battery terminal respectively to four bus bars with

voltages differing from each other by about 5 volts. When a battery is first brought in for charging it is connected to the bus bar giving the lowest voltage, and when on this bus the charging current becomes less than 10 amperes the red lamp is illuminated. The attendant then turns the switch to throw the battery on to the next higher bus, and so on until, when the red lamp shines on the highest voltage, the charging process is complete and the battery may be removed. Since one pair of pilot lamps serves for the eight tables connected to the one panel of the indicator board, some means must be provided for preventing any indicating solenoid from illuminating the red lamp when there is no battery on the corresponding table, and consequently no current in the solenoid. This is accomplished by means of a pair of contact rings attached to each rotary switch, the contact bearing thereon cutting off the lamps from the contacts of the corresponding indicator when the switch is on open circuit; thus the lamps indicate only for tables in actual service, and if more than one table is in service on one indicator board the attendant can readily tell

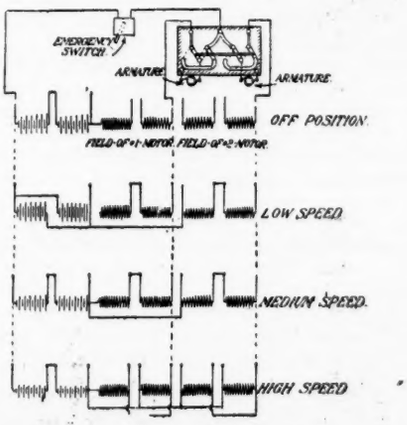


Fig. 4.—Controller Combination.

which one is affecting the lamps by a glance at the ammeters. One-half of the indicator boards is supplied with current from the positive side of the three-wire 240-volt system; the other half from the negative side, and the demand for current is equalised between the two sides by the simple process of running in no neutral. On this account the aggregate current taken on the positive side must, of course, equal that on the negative side, and on whichever side there are fewer batteries the rate of charging will be more rapid. When, however, the station is fully loaded, it will be a simple matter to equalise the number of charging tables in use on the two sides of the system.

The current reaches the indicator panels from the main board by eight bus bars (four positive and four negative) of rectangular cross section, varying from $\frac{1}{4} \times 1$ inch to $\frac{3}{8} \times 1\frac{1}{4}$ inches. This board is a handsome structure of Vermont marble divided into nine panels and inclosed in a glass case to keep out acid fumes. One of the panels controls the various light and motor circuits of the station, the other eight supplying the eight bus bars referred to above. The voltage differentiation is obtained by means of two boosters coupled to one motor, which give the highest voltage on the positive and negative sides respectively, the next highest being that of the supply mains themselves. The two lower voltages are obtained by passing the current through large enamel rheostats, the resistance of which can be varied by hand. The panels each contain an illuminated dial Weston voltmeter and ammeter, and a Bristol recording voltmeter and ammeter. A voltmeter switch on each panel allows the corresponding indicating instrument to be connected to measure up the voltage on the incoming supply bus, or the bus attached to that panel. Below the measuring instruments are a single-pole switch and a circuit breaker. The latter is fitted for an underload release as well as the customary overload. The underload release is effected by a magnet energised by a winding above the other parts of the breaker, the armature of which is attached to a pin which, shortly after the armature is released, strikes the trigger in such a way that it is tripped just as though struck by the regulation overload device. Current is supplied from the underground mains of the Edison Electric Illuminating Company over two independent services, the incoming cables having a cross section of 1,250,000 cm. The Edison Company has a station only about 600 feet away, so that the drop is but slight.

Handling the Batteries.

The design and construction of the machinery for removing the batteries from the carriages and placing them upon the charging tables and *vice versâ* was no easy task. The trays, with their accumulators, weighing about 1,300 lbs., must be pulled from a position on a spring-supported wheeled vehicle and transported to any one of 200 positions in the charging room, and *vice versâ*. As may be seen, this manipulation is more difficult than the removal of battery trays hung under a street car truck, as in the latest designs of battery traction equipments, since the tray must be moved out horizontally to and from its place instead of vertically. The manipulation resembles more than anything else the handling of steel billets in the reheating furnaces of rolling mills, but the apparatus must be more elaborate than in the latter case, owing to the necessity of working with a movable wheeled vehicle, the body of which is mounted on springs.

To make the operation clear, the course of the battery from the time it arrives in an exhausted condition in its vehicle will be described. The vehicle is first moved on to a platform, of which two are provided in front of the end of the battery charging room, with its battery end towards the latter. If the vehicle is a hansom it is backed in; if a brougham, it runs in a forward direction, the door through which the battery is removed being open in either case. The platform on which the vehicle runs is divided into two parts, on one of which rest the forward wheels, and on the other the rear wheels, these two parts being laterally and independently movable. Once on this platform, a long horizontal shoe is advanced toward each side of the vehicle by two hydraulic cylinders, the shoe being of a proper height to push against the wheel hubs, centring the vehicle, which moves without slipping of the wheels, owing to the movable nature of the platforms below it, into the proper position. The vehicle is then backed in until heavy iron straps on its advancing end catch in latches projecting from the table, toward which it advances. When in the proper position two hydraulic cylinders below the sliding platforms lift their cross-heads through the floor—in which are provided hinged slats to allow this motion—and pick up the body of the vehicle, raising it off from its spring to a fixed height independent of the load. This is necessary, since, if it were not done, the removal of the heavy battery would allow the vehicle to jump up, making the level of the battery compartment dependent on the condition of the springs, &c.

The body being raised to the proper height, there advances toward the open door of the battery chamber a hook attached to the piston of a horizontal hydraulic cylinder. This latches into the frame of the battery tray, and on the application of pressure pulls the latter out on to what is known as the conveyer table. The latter consists of a runway across the whole front of the battery charging room, equipped with a chain conveyer with frames attached thereto on which the battery trays may be carried to any desired position along the table.

Above the table is an 8-ton crane, its bridge spanning the battery charging room, and carrying, instead of a trolley, eight hooks or grabs. Any one of these hooks may be made to descend and catch under the two sides of the battery tray and lift the latter to a level immediately below the crane bridge. The crane then moves as a whole down the length of the battery room to a position over the battery charging table on which it is desired to deposit the tray. In lowering the hooks the tray is deposited, its own weight closing the contacts for charging its cells. The crane may be then removed to any other position, its eight hooks moving respectively over the eight rows of charging tables up and down the room and enabling one tray of batteries to be picked up from any one of these rows each time it passes over them. Returning to the position over the conveyer table, the batteries may be lowered on to the latter and moved along until they arrive at a position opposite the

vehicle to be loaded, when they are in turn pushed in by the same hydraulic cylinder which pulls the exhausted sets out. There are two platforms on which the vehicles can approach the conveyer table, and, the capacity of the crane being several sets of batteries with which it can be fully loaded before it moves back over the charging tables, returning again with several fresh batteries, it is expected that the accumulators in any carriage can be replaced inside of three minutes' time, and a capacity of about 20 carriages per hour can be obtained. Carriages have already been loaded in 3½ minutes.

The various movements of the conveyer table, crane, hoist, &c., are effected by electric motors, all of which, some 14 in number, are of the same make and size, 5 horse-power, so that their parts are interchangeable. The conveyer table and bridge mechanism of the crane are each fitted with a reserve motor for emergency use. Beside the two loading platforms in front of the conveyer table, there is a third in reserve fitted to unload on to a small car, on which the batteries can be wheeled under any hook of the crane. The whole plant is interlocking, the conveyer table motor being inoperative when the conveying chains are latched, the bridge travel motor being inoperative when the bridge is latched, and also when any one of the hooks is down. Everything can be manipulated from one platform which hangs from the crane to a position near the ground, running in an isle down the middle of the battery room. When the crane has advanced to a position over the conveyer table, the controlling handles of the latter and the valve spindles of the various hydraulic cylinders are within easy reach from the platform, so that one man alone can handle the batteries from the vehicle to the charging tables. The various movements are well equipped with braking mechanisms, the hoists and conveyer table having electric brakes, and the bridge travel a hand brake. The conveyer table is also fitted with limit stop switches, so that if the attendant is careless and leaves the conveyer running, in which case the trays thereon would be tipped off the end, the switch arm is struck by the battery tray, which cuts off the current and applies the electric brake.

Water pressure for the various hydraulic cylinders is supplied by a triplex pump belted to a motor similar to those on the crane, conveyer table, &c. A 36-inch tank about 9 feet high gives an ample air cushion, the water pressure being 150 lbs. to the square inch. A Mason by-pass valve is now in use to prevent the pressure rising too high, but there will be substituted for this an automatic motor controller which will start and stop the motor at such times as to maintain the proper water pressure.

The work was designed and carried out under the direction of Mr. G. Herbert Condict, who previously had similar experience in designing the charging station of the Chicago and Englewood storage battery railway. Mr. Condict was assisted in this work by Mr. A. W. Gilbert, who acted as superintendent of construction.

An Austrian Mechanical Stoker.—The *Revue Industrielle* describes a mechanical stoker of somewhat novel make. It consists of two systems of transverse bars. One set is hollow, and they are supported at each end upon longitudinal hollow bearers, the joint being made with asbestos. A current of air can thus be sent round the whole of the bars for refrigerating them, and even water vapour may be thus circulated. The second set is also placed transversely between the other bars. These second bars are pierced, and they can be moved to and fro. As they point in cross section upwards and forwards, a sliding motion implies that they alternately move up into the fire which they push forward every stroke, and then they retire and allow the fire to settle on the first set of bars. The fire is thus gradually crept forward. The feeding of the furnace is by means of the well-known sliding plunger from a hopper. The longitudinal bearers are divided up by transverse webs in such a way that the current of cooling air is made to travel in a zig-zag direction through all the first set of bars, finally escaping at an opening in front of the fire. It is claimed that the furnace is a preventer of smoke and very economical, and that the English Admiralty have decided to give it a trial. We do not ourselves see anything very novel except, perhaps, in the sloping bars and the movement of the alternate bars and the method of creeping the fire forward.

PRESTON'S INVESTIGATIONS ON THE ZEEMAN EFFECT.

In the end of 1896, Dr. P. Zeeman, a young Dutch physicist, while working in the laboratory at Leyden, made the important discovery that the bright lines of the spectrum were broadened when the source of light was placed in a strong magnetic field.

This interesting phenomenon was immediately taken up by the theorists; and Prof. Lorentz, amongst others, successfully attacked the subject, and deduced from his theory of the charged atom, two remarkable conclusions. His theory indicated that each bright line of a line spectrum should be converted into a doublet when the source of light was viewed *along* the lines of magnetic force, and into a triplet when the source of light was viewed *at right angles* to the lines of magnetic force. Moreover, the theory predicted that each line of the doublet would be circularly polarised, but, in opposite directions; and that all the lines of the triplet would be plane polarised, the plane of polarisation of the two outer lines being the same, and at right angles to the plane of polarisation of the middle line. Zeeman verified experimentally most of these predictions of theory, though the visible separation of the lines into triplets appears to have been first effected by Mr. T. Preston in the experiments which he recently described at the British Association, and which we propose to describe in this article.

A rough sketch of the Lorentz theory will be of use in understanding Preston's results. Each molecule or atom of the substance emitting light, is assumed to have a small electric charge, e, and to revolve in an ellipse under the action of an elastic central force proportional to the distance from the centre. The rapidly rotating electric charge will be acted on by a magnetic field, as if it were an electric current, *i.e.*, the path of the electrified atom will move so as to cut lines of force. An electrified atom revolving in a plane at right angles to the lines of force, will therefore have its periodicity increased or diminished, according as the electro-magnetic force increases or diminishes the central force originally acting on the atom. If, when the electrified atom rotates in one direction the central force acting upon it is increased, then when it rotates in the opposite direction this force will be diminished. The only circumstance, therefore, which determines the periodicity of *transverse* electric waves viewed along the lines of magnetic force, is the direction of rotation of the electrified atoms or molecules which give rise to these waves. Hence arises the circularly polarised doublet, seen when the light is viewed through the spectroscope along the lines of magnetic force.

When the light in the magnetic field is looked at across the lines of force, the results are different. The motion of

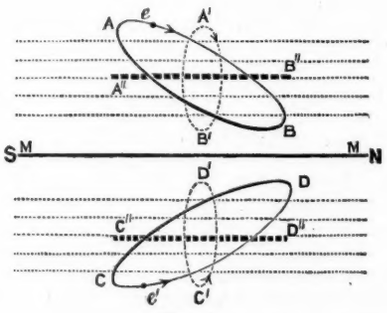


Fig. 1

a rotating atom, e, may be resolved into a straight oscillation, A'' B'', parallel to the lines of magnetic force, and a rotation, A' B', on a plane at right angles to the lines of magnetic force. As we have seen, the frequency of the motion in the plane at right angles to the lines of magnetic force is either increased or reduced according to the direction of rotation of the atom. The oscillation of the atoms along the lines of force is not affected by the magnetic field, since the path of the atoms nowhere cuts lines of force.

The light proceeding from the source at right angles to the lines of force will, therefore, be made up of two kinds of transverse waves, namely, waves parallel to the lines of force whose original frequency will not be affected by the magnetic field, and waves at right angles to the lines of force, one-half of which will have their frequency less, and the other half of which will have their frequency greater than the initial frequency. These are exactly the conditions which will cause the spectroscope to resolve a single bright line into three, of which the two outer lines will be plane polarised in a direction at right angles to the plane of polarisation of the middle line.

A study of the diagram, fig. 1, will perhaps help to fix our ideas of what takes place in the magnetic field. The atoms or molecules of the incandescent substance may be divided into two classes, according to their direction of rotation. Let A B and C D represent the elliptical orbits of two such atoms, rotating in opposite directions; these orbits may be chosen so that one is the reflection of the other in an imaginary plane mirror, M M. N, S, are the poles of the magnet and lines of force passing through the orbits, A B and C D are represented by dotted lines. The orbit A B may be resolved into a straight oscillation A″ B″ parallel to the lines of force, and an elliptical or circular orbit A′ B′ in a plane at right angles to the lines of force; and a similar analysis is applicable to C D. When the magnetic field is turned on, the periodicity of the rotation in the orbit A′ B′ is, say, increased, and that in C′ D′ is diminished, but the rate of oscillation along A″ B″ and C″ D″ remains unchanged. If visible, the orbits A B and C D would appear to rotate about the lines of force in opposite directions.

The following mathematical investigation of this theory, due to Larmor,* will interest those who may desire a more exact statement. Let it be assumed that an ion e, of mass M, describes an elliptical orbit about a centre of attraction proportional to the distance of the ion from this centre, then

$$(\ddot{x}, \ddot{y}, \ddot{z}) = -a^2 (x\ y\ z)$$

and the frequency of oscillation $= \frac{a}{2\pi}$.

Now introduce a magnetic field H, in the direction (l, m, n) and the equations become

$$\ddot{x} = -a^2 x + k(n\dot{y} - m\dot{z})$$
$$\ddot{y} = -a^2 y + k(l\dot{z} - n\dot{x})$$
$$\ddot{z} = -a^2 z + k(m\dot{x} - l\dot{y})$$

where $k = \frac{e\,H}{M\,c^2}$, in which c is the velocity of radiation.

To obtain the frequencies $p/2\pi$ of the oscillations thus modified, we make as usual $(x\ y\ z)\ e^{ipt}$, and this gives, after easy reduction, an equation for p,

$$(p^2 - a^2)^3 - k^2 p^2 (p^2 - a^2) = 0.$$

Thus corresponding to each original period represented by $p = a$, there are three modified ones:—

$$p = a,$$

and

$$p^2 \pm k p - a^2 = 0.$$

When k is very small,

$$p = a + k^2/8\,a \pm \tfrac{1}{2} k,$$

or

$$p = a \pm \tfrac{1}{2} k.$$

Each vibration period will consequently be tripled, and the modification thus produced is the same whatever be the orientation of the orbit with respect to the magnetic field.

The oscillation as modified by the magnetic field will be brought back to its original aspect if the observer be attached to a frame which revolves with angular velocity $\frac{1}{2} k$ or $e\,H/2\,M\,c^2$, round the axis of the magnetic field. In a circular orbit described one way round this axis the apparent rotation will be retarded, in the other way, accelerated; in a linear oscillation along the axis there will be no alteration; hence the three frequencies.

So much for theory; but are these remarkable results confirmed by experiment? This is the question which Mr. T. Preston, M.A., has set himself to answer. The answer is that, in general, the predictions of the theory are verified by experiment, but there are a considerable number of as yet unexplained deviations.

For obtaining his line spectrum Mr. Preston used an excellent Rowland concave grating mounted in the Physical Laboratory of the Royal University of Ireland. This instrument is of the usual type, having a radius of 21·5 feet, and is ruled with about 14,438 lines to the inch. It is fitted with a camera box which takes a photographic plate 50 cm. long and 6 cm. broad, so that a length of the spectrum equal to half a metre approximately can be photographed at a single exposure.

Possessing this fine instrument, Preston decided to *photograph* the results, in addition to making observations by the eye. Photography enabled him to obtain a permanent record of a considerable number of lines simultaneously, but had the disadvantage that it did not indicate rapid changes; these were best examined by the eye.

Though Dr. Zeeman distinctly states that he obtained a tripling of the spectral lines when the source of light is viewed across the lines of magnetic force, and a doubling when it is viewed along the lines of force, yet these results were obtained only after the theory of the phenomena pointed in this direction, and other reliable observers investigating the same lines have expressed the opinion that when viewed *across* the lines of force a doubling like a reversal, or a broadening combined with a doubling occurred. As far as Preston is aware, all these observers have failed to obtain distinct triplets when the light is viewed across the lines of force, that is, they have not succeeded in separating the constituents sufficiently to enable them to decide what the exact composition of the modified spectral line is. By placing a Nicol's prism in the path of the light, it has been determined that the central part of the modified line is plane polarised, and that the edges are also plane polarised, but in a plane at right angles to the plane of polarisation of the middle part. Thus, with the nicol in one position, the middle may be cut out, leaving the two border lines, and with the nicol turned through a right angle, the two border lines may be removed, leaving the middle portion alone. It is to be remarked, however, that observations of this kind, although they are in accordance with the supposition that the modified line is a triplet, yet they do not actually prove tripling, pure and simple. For this purpose it is necessary to obtain high resolving power, and a magnetic field strong enough to separate completely the constituent parts of the modified line, so that each can be observed separately, without the complications attending the overlapping of others.

Preston failed in his first experiments in tripling the lines, but finally succeeded by pushing the pole-pieces of his magnet very close together, and working with a very short spark as a source of light, in obtaining photographs which showed the triplets with a magnifying glass. With a more powerful electro-magnet, lent him by the Rt. Rev. Monsignor Molloy, he was able to obtain photographs which showed triplets visible to the naked eye, without any magnification whatever. It was with this latter apparatus that the experiments were made, the results of which we now proceed to give.

(To be continued.)

* *Phil. Mag.*, p. 503, 1897.

HOW TO DESIGN A DYNAMO.*

We must now make some preliminary calculations to see whether or no the armature we have designed in the last section will overheat.

There are two sources of heat in an armature under load, viz., the core loss and the wire loss. The core loss, in turn, consists of two parts, that due to eddy currents, and that due to hysteresis. The loss by eddy currents it is impossible to calculate. It depends upon the specific resistance of the metal, the degree of lamination of the core, the quality of insulation of the laminations, conditions which it is very hard to determine, and even if they be known, the formulæ

* *American Electrician.* The first article appeared in Electrical Review, August 26th, 1898, p. 297.

will be highly empirical. Fortunately, eddy current losses are usually slight.

Hysteresis, on the other hand, is very readily calculated by the aid of appropriate tables. These tables, which are to be found in many reference books, usually give the loss in watts, per cycle, per second, per cubic inch of iron, for the various densities of magnetisation. We must, therefore, calculate the number of cubic inches of iron in the various parts of our armature, and determine the magnetisations to which they are subjected. The teeth we already know to be substantially trapezoidal in section, with an altitude of 695·8 mils, and we can readily compute the average width, which we will find to be 211 mils. This gives a section of ·1466 square inch. Multiplying this by 11, the length of the armature, we obtain the volume of one tooth, and by 42, we obtain 67·75, the volume of all the teeth in cubic inches. To find the maximum flux to which these teeth are subject, it is necessary to compute the area of each tooth at the root. The dimensions, as we already know, are ·1585 inch wide by 11 inches long. We must now assume a polar arc, in order to find how many teeth are doing duty in carrying the flux. The poles are commonly supposed to cover two-thirds of the armature, the remaining one-third being split up into gaps between the pole-tips. Therefore, one-third of the teeth are carrying the total flux—that is, practically 14 teeth are carrying the total flux of 3,095,240. The effective area of the roots of the 14 teeth is 24·4 square inches, and hence the density is 126,500 lines per square inch. Referring to tables, we find that the number of watts lost per cycle per minute in a cubic inch of iron at that density is ·00047.

We have 67·74 cubic inches of iron, and as we are running at 1,500 revolutions, we have 1,500 cycles per minute, the total watt loss due to hysteresis in the teeth is $67{\cdot}74 \times 1{,}500 \times {\cdot}00047 = 47{\cdot}7$ watts.

We now come to the hysteresis in the armature body proper. That was designed with iron area to carry 70,000 lines per square inch. The iron carrying this flux is a hollow cylinder about 5·1 inches in external diameter, by 1½ inches in internal diameter. Its volume is, therefore, 211·3 cubic inches, and applying similar methods, we find the loss in this part of the core to be 63·4 watts.

We now pass to the calculation of the wire loss. The length of each turn consists of a loop, the sides of which are each 11 inches, and the ends about 7½ inches. Although the armature is 6½ inches in diameter, we must add a certain amount on account of overlapping of the ends. This makes the total length of loop 37 inches. We have 84 such loops, giving a total length of wire on the armature of 84 × 37, or 3,108 inches. We selected in the first place No. 8 Brown and Sharpe wire, and the resistance of such a piece of wire, computed from the wire tables, is ·163 ohms. The current circulating in this wire at full load is 27½ amperes, and the loss in watts is obtained by squaring the current and multiplying by the resistance, and will be found to be 123·1 watts. We must now refer to practical experience, and that tells us that if the armature losses do not exceed 1 watt per square inch of radiating surface there is no danger of overheating. The armature consists of a cylinder, which in its completed state will be about 12 inches long and 6½ inches in diameter. The surface of such a cylinder is 312 square inches, giving a radiation of about ·75 watts per square inch. This shows that the armature is very suitably designed for its work; in fact, it would carry a substantial overload without trouble.

We must also remember that we have figured very liberally in making this calculation. We have, for instance, assumed for the total density throughout the teeth that at the narrowest section, which is not strictly the fact, and we have also figured the armature as a solid mass of iron, whereas it is made up of laminæ, and the assumption that it was solid erred perhaps within 5 or 6 per cent., according to the thickness of the insulation between the plates. It is, however, always best to figure in this way, for calculations on hysteresis loss are apt to be thrown many per cent. astray, due to the fact that iron is not at all uniform in this respect. In fact, it may easily be that of two samples, apparently similar, one will consume twice as much energy as the other, when subject to a certain cycle of magnetisation.

It is not the purpose of these lessons to take up mechanical points in design and construction, but simply to show how to determine magnetic and electrical dimensions. We may now summarise the following for our armature:—

Core disc, external diameter	6½ inches.
Core disc, internal diameter	1½ "
Number of slots	42
Width of slot	225·5 mils.
Depth of slot	695·8 "
Thickness of slot insulation	35 "
Size of armature wire	No. 8 Brown & Sharpe.
Number of wires per slot	4
Total number of wires	168
Number of bars in commutator	42
Length of core	11 inches.

Before finally accepting this design we must make one more precautionary calculation, that of the peripheral speed. To do this we, of course, multiply the circumference in feet by the number of revolutions per minute, obtaining a peripheral speed of 2,550 feet per minute. A conductor velocity under 4,000 feet per minute is permissible in such an armature, and hence we may regard the design as satisfactory and proceed to the field magnet calculation.

In calculating the field magnet we must first determine what material shall be used; something about its magnetic permeability, and similar matters. We must further determine what is known as the leakage coefficient. It is a fact that of all the lines generated in a field magnet frequently one-third, or sometimes as much as one-half, are lost in leakage; and the ratio of the total flux to the useful flux is known as the leakage coefficient.

There exist a great many empirical formulæ for calculating this leakage coefficient beforehand, and they are moderately reliable, though somewhat complicated in their application. A practical designer is usually well acquainted with the leakage coefficients of the various types of field magnet, which he is wont to adopt and can make a very shrewd guess as to what the average leakage coefficient will be. Moreover, in designing a field magnet, a margin is always allowed for rheostatic control, and this margin ought to exceed any error in leakage coefficient determination. For the purpose of this article it is sufficient to select the leakage coefficient from the table of average values given in the August number. For a 5-kw. machine this is 1·6. It therefore follows that we must generate in the field magnet 1·6 times the number of useful lines we use in the armature, which will amount to 4,952,384 lines of force. We will further assume that the field magnet be a steel casting, which can be comfortably worked at 90,000 lines to the square inch, without using excessive magnetising power. The area of the field magnet waist must be therefore 55·02 square inches, and if we assume this area to be circular, it will have a diameter of 8·36 inches. The next question is the length of this magnet waist.

From a theoretical point of view, this magnet waist should be just long enough to allow the requisite number of ampere-turns to be wound upon it, for any added length increases the length of the magnetic circuit. Practically speaking, such a construction is a mistake, because it is frequently desirable to rewind the field magnet and frame for other voltages and capacities, and some flexibility in the size of the bobbin that may be put on is highly desirable. Moreover, the reduced length of the magnetic circuit, obtained by careful calculation, would only diminish its reluctance a very few per cent., and the gain in magnetising energy would be almost microscopic.

We may take as a reasonable assumption, for the purposes of preliminary calculation, that the total reluctance of the magnetic circuit is equal to double the reluctance of the gap space. This proportion obtains in good dynamo design. The reluctance of the gap space has already been determined by our previous assumptions.

Its area is practically equal to the area of the polar faces, and its length is the minimum length that mechanical conditions will permit, and may in this machine be as close as $\frac{1}{20}$th of an inch. If, therefore, we multiply the total number of lines of force by this length in inches and divide it by the area and multiply that result by ·3132, a constant which transforms C.G.S. magnetising force into ampere-turns, and also takes into account English measures, we shall obtain the number of ampere-turns necessary to force the flux through one of the gap spaces. As there are two gap spaces we must double this amount. The calculations are shown below:—

$$\text{Area of pole piece} = \frac{6{\cdot}5 \times 3{\cdot}1416 \times 11}{8} = 75.$$

$$\text{Ampere-turns} = \frac{3{,}095{,}240 \times \cdot05 \times \cdot3131}{75} = 648 \text{ for one gap.}$$

Ampere-turns both gaps = 1,396.

If we take double the ampere-turns necessary for the gap spaces we shall find the total ampere-turns to be 3,792, and we are ready to determine approximately the size of the shunt wire necessary to produce this magnetisation, and from that to gain an idea of the size of the field coil.

It is to be understood that these calculations are preliminary, and, having thus obtained the dimensions, it will be necessary to review the latter carefully, and modify them where they are objectionable. Such methods as this are frequently used in dynamo design, and in all other cases where results that are opposed to each other are desirable. Thus it is desirable to have low speed, small exciting current and minimum armature reaction. Low speed demands strong field and many armature conductors. Small armature reaction, on the other hand, requires few armature conductors, and strong field requires large exciting current. It will be necessary, therefore, to subsequently adjust these conflicting conditions to a happy medium.

ATMOSPHERIC RESISTANCE TO TRAINS.

The resistance to the motion of trains due to the atmosphere is, and always has been, a doubtful point. The only generally-accepted fact has been that the effect of side wind is more serious than head wind, and close coupling or vestibuling seems to be accepted as offering less resistance than wide coupling.

Prof. Goss, of Purdue, has been investigating head resistance, and has communicated his results to the Western Railway Club. The experiments involved the use of a rectangular conduit in which a current of air could be maintained, and in this conduit model cars were exposed to the air current either singly or in series as a train. We shall endeavour to extract the pith of a somewhat lengthy paper, while at the same time expressing a doubt as to whether a train at rest in a current of air can rightly be held to bear a strict resemblance to a train in motion through unconfined air. It seems to us that the conditions are quite different. The conduit employed was of wood, 20 inches × 20 inches cross section and 60 feet long. It was smooth varnished inside, and supplied with air by a fan capable of giving a velocity up to 100 miles per hour, the velocity being determined by Pitot's tubes. The relation of the water gauge and air velocity being expressed by the equation $v^2 = 2\,g\,h$, where v is velocity in feet per second h is water gauge in feet translated into terms of the density of the stream to be measured. We need not repeat the observations as to the air eddies and so on, suffice that the experiments were made in a part of the tube where the flow had steadied itself into straight lines. The models used were to $\frac{1}{32}$nd scale of a box car, or $12\frac{1}{16}$ inches long, $3\frac{3}{8}$ inches wide, and $4\frac{1}{2}$ inches high. The experiments showed that in every case the force tending to displace the model, as measured by the dynamometer balance, was less than the calculated wind pressure multiplied by the cross sectional area. Approximately it is about half what calculation would indicate.

Where two models were exposed together, the pressure on the first was about 40 per cent. of the calculated amount, due probably to the absence of suction, which was taken by the second model.

On the second model the pressure was 0·14 of the calculated amount, so that the joint effect on two models was little greater than that on one model, or 0·54 as against 0·50. The resistance of the first model always seems to be the same, no matter how many models followed it. The head resistance seems thus to be simply a function of the velocity of current only, and is, approximately, 0·4 of the calculated force based on the pressure equivalent of the velocity multiplied by the cross sectional area.

The force upon the last model becomes less as the train is lengthened. Thus with two models, the end one takes 0·14 of its supposed amount; with three models, the last one takes 0·13, and with five models, 0·12. With 10 models, the resistance comes down to about 10 per cent., and it is still 10 per cent. for 25 models, showing that beyond a given length the number of vehicles has no further reducing effect.

In all trains the second model is exposed to less resistance than any other, but all other intermediate models seem to have met an equal resistance wherever placed.

Thus, in a 10-model train the cars from third to ninth, at 64 miles velocity per hour, the force in pounds was ·038, ·038, ·040, ·038, ·039, ·040, ·039, or between 3·8 and 4 per cent. of the amount calculated from the pressure and cross section.

The side friction of a train is thus seen to be a constant function of the velocity. It would appear, therefore, that train resistance is made up of a head resistance and a tail resistance, and a side resistance, which is dependent upon and a function of train length.

The following equations are deduced from the observations where a is the force in pounds acting upon the model, and v is the velocity in miles per hour:—

For single model...	$a_1 = 0{\cdot}000116\ v^2$
„ first model of a train ...	$a_f = 0{\cdot}000097\ v^2$
„ last model	$a_l = 0{\cdot}000025\ v^2$
„ second model	$a_s = 0{\cdot}000008\ v^2$
„ any intermediate model ...	$a_i = 0{\cdot}000010\ v^2$

Of course these equations are not of general value, as they are based on particular models.

Reduced to 1 square foot area when P is the pressure in pounds per square foot, and v is given in miles per hour, we have:—

For the Pitot gauge	$P = \cdot0025\ v^2$
„ one model alone	$P_1 = \cdot0012\ v^2$
„ first model	$P_f = \cdot001\ v^2$
„ last model	$P_l = 00026\ v^2$
„ second model	$P_s = \cdot00008\ v^2$
„ any intermediate model ...	$P_i = \cdot0001\ v^2$

As the models were only $\frac{1}{32}$nd of actual car sizes, the resistance of a full-sized car would be $A = a \times 32^2$, or $A = 1{,}924\ a$, or approximately for A in pounds, v in miles per hour:—

$$A_1 = \cdot119\ v^2$$
$$A_f = \cdot99\ v^2$$
$$A_l = \cdot026\ v^2$$
$$A_s = \cdot008\ v^2$$
$$A_i = \cdot010\ v^2$$

The first car may be taken as the locomotive, the second car as the tender. These two vehicles, at 40 miles per hour, will offer a resistance of 200 lbs. when running alone, 174 lbs. when heading a train. A train of engine and tender and 20 cars will require a tractive force of 520 lbs. at 40 miles velocity. The cars alone behind the tender call for 346 lbs., and so on. Passenger cars are looked on as equal to a couple of freight cars, and treated accordingly.

The author considers that the experiments justify him in concluding that his results may be applied with reasonable accuracy to full size cars, and from the foregoing equations he deduces a table of results for various speeds, which we give:—

Speed miles per hour.	Engine and tender running alone.		Engine and tender running at head of train.	
	Traction.	Horse-power.	Traction.	Horse-power.
10	13	0·35	11	0·29
20	52	2·8	44	2·3
30	117	9·4	99	7·9
40	208	22·0	176	19·
50	325	43·	275	37·
60	468	75·	396	63·
70	637	119·	539	101·
80	822	178·	704	150·
90	1,050	253·	891	214·
100	1,300	347	1,100	293·

These figures, if correct, point to very considerable powers at high velocities, considerably more, indeed, than many will allow. Indeed, head resistance has been pooh-poohed very much in certain quarters, though, it must be admitted, without sufficient reason.

Simplifying to two significant figures, the calculable resistances may thus be set down:—

For locomotive and tender alone	...	... A = ·13 v^2.
" " "	at head of train	A = ·11 v^2.
" last freight car	... ...	... A = ·026 v^2.
" last passenger car	... ...	... A = ·036 v^2.
" each intermediate 33 feet car		... A = ·01 v^2.
" " 66 feet car		... A = ·02 v^2.

For train of freight cars, engine, and tender—

$$A = (\cdot 13 + \cdot 01\ c)\ v^2$$ where c is the number of cars.

The same for freight cars alone following engine—

$$A = (\cdot 016 + \cdot 01\ c)\ v^2.$$

For passenger train—

$$A = (\cdot 13 + \cdot 02\ c)\ v^2.$$

For same not including engine—

$$A = (\cdot 016 + \cdot 02\ c)\ v^2.$$

For any train passenger or freight with locomotive $A = \cdot 0003\ (L + 347)\ v^2$ where L is the train length in feet.

For any train following, but not including locomotive, $A = \cdot 0003\ (l + 53)\ v^2$, where l is the total car length.

These figures are, of course, only applicable to American practice, with steam locomotives and cars; but no doubt they can be fitted to cars of any size. They are deduced from car models of $\frac{1}{32}$nd scale, and are fully as likely to be correct for small cars as for full-sized steam railroad cars.

The figures generally do not indicate very serious power absorption at small speeds. Still, even 9·4 horse-power, at 30 miles per hour is coming within the range of ordinary electrical work and speeds, and may be worth reducing if such things as pointed prows have any real value in this direction.

RÖNTGEN RAY THEORY.

In his presidential address at Bristol, Sir W. Crookes said that "while the general opinion of physicists seems to be settling towards a wave or ether theory, an opposite drift is apparent with respect to the physical nature of the cathode rays." A paper in the September number of *Wiedemann's Annalen* (p. 74), by Herr Walter, of Hamburg, on the nature of the Röntgen rays, shows that the settling towards the wave theory is by no means universal. Starting with Crookes's theory, that the cathode rays are a stream of charged particles moving at a high velocity, Walter assumes that the Röntgen rays are the same particles after they have completely lost their electric charge by their impact on the anti-cathode. Walter cites many characteristic differences between the cathode and Röntgen rays which can be deduced from this theory. The cathode particles having an electric charge are deflected by the magnetic field; the Röntgen particles, having no charge, are not deflected. The superior penetrability of the Röntgen rays is explained by the circumstance that the unelectrified particles are less attracted by the electric charges on the particles of the bodies through which they pass, while the charged cathode particles are very soon pulled into collision. Measurements have shown that the ratio of the charge to the mass of a cathode particle is about a thousand times as great as the same ratio in the electrolytic ion.

Seeing that the only difference between cathode and Röntgen rays is the presence or absence of an electric charge, it is to be expected that many of their properties will be the same in kind, if not in degree. Now it is well known that both kinds of rays excite phosphorescence (Villard has even observed that the phosphorescent screen becomes "tired" under the action of X rays, as glass becomes "tired" under the action of cathode rays); both kind of rays act on the photographic plate; both give rise to similar chemical reactions.

The law of diffuse reflection has also been found to be similar for the two kinds, inasmuch as the efficiency of the diffusion depends in both cases on the atomic weight of the diffusing material. This has been established by Kaufmann for the cathode rays and by Voller and Walter (*W. A.*, 61, p. 88, 1897) for the X rays.

Refraction and polarisation are, of course, impossible according to Walter's hypothesis; and these have never with certainty been experimentally established as properties of the X rays. This crucial experimental result has, however, not discouraged the advocates of the wave theory. They appear to rely on a theoretical result deduced from Helmholtz's theory that there is one special frequency at which light waves would not be refracted. Why X rays should always have this particular frequency has never yet been explained.

The fact that the absorption of X rays should be approximately proportional to the atomic weight requires no explanation with the emission theory; but one circumstance in connection with absorption is of special interest in its bearing on this theory. The magnet shows that cathode rays are not homogeneous; and the perfectly satisfactory explanation usually given is that the break of the induction coil produces in rapid succession a series of E.M.Fs. of decreasing amount. The velocities of the charged particles driven off by a single break will, therefore, not be all the same. It would follow from the present theory that various velocities would also exist among the X rays, and abundant experimental proof has been given by Röntgen and others that X rays of different penetrability (and consequently of different velocity) exist in the same beam.

Walter's theory is not altogether new; in fact, he himself says that he has learned since he worked it out that a similar theory was published by Vosmaer and Ortt (*Nature*, 56, p. 316, 1897); but the theory of these latter physicists differed from Walter's, in that they did not assume a complete neutrality of the Röntgen particles. In fact, they ascribed the want of homogeneity in the X rays to differences in the degree of their neutrality. As Walter points out, this assumption is untenable, in view of the absence of magnetic deflectibility in the X rays.

An experiment made by Porter appears to tell against an emission theory. He found that no difference resulted in the photograph obtained when a metal plate through or near which the rays passed was charged with electricity. Walter admits that this tells against his theory, but contends that the absence of electrostatic deflectibility in the cathode rays makes it easier to understand why there should be no sensibility to electrostatic effects exhibited by the electrified Röntgen particles.

MODERN ARC LIGHTING PLANT.

The *American Electrician* describes the change-over of a central station with steam power into a sub-station driven by three-phase electrical power. Last year the Brooklyn Edison Company absorbed the Citizen's Company, and as soon as they had completed their large station at Bay Ridge, they prepared plans to convert the old central station into a sub-station, and dispensed with the steam plant.

The old steam plant consisted of five 400-H.P. triple expansion engines and one 1,200-H.P. compound engine. They drove, through countershafts, 20 120-light 1,200 C.P. Brush machines, and, in addition, two 150-H.P. bipolar Edison motors, operated by current from the low tension mains, furnished additional power after 7 p.m., but during the day these were driven as generators. So far, all the engines have been removed, excepting three triple expansion, retained to drive the machines not yet moved.

The new plant, including synchronous motors, arc machines, booster and switchboard, and battery plant, are all placed in the space formerly occupied by the steam portion alone of the old arc lighting plant. Each new arc generator unit consists of one G.E. 100 kw. synchronous motor directly connected to two 120-Brush arc machines. The driving is done from each end of the motor-shaft through two four-armed star couplings with rubber cushions. The motors are of the revolving field type; they run at 750 revolutions, and have four poles. The field excitation is 125 volts.

Each pole has wound close to the iron a heavy copper strip, short-circuited on itself, the ordinary field winding being outside of this copper strip or shield, with its ends carried to two collector rings with carbon brushes. The stationary armature has a substantial connection board at one side near the base, and the leads are brought out from

this and furnished with couplings encased completely in hard rubber.

A three-phase reactance coil is placed in circuit with the armature when starting, and cut out by a switch when the machine has reached synchronism. This limits the current taken from the line when starting, and the potential of the transmission lines remains unaffected.

The field excitation is also provided with a rheostat for adjustment, so that the minimum current input will be taken for any given load. These motors take the full 6,000 volts current from the transmission lines of the Union station without any reduction. In size these motors measure over all 86 inches × 57½ inches × 52½ inches × 11,000 lbs. The arc light generators are four-pole Brush open coil machines, rated at 6,000 volts, 6·6 amperes at 700 revolutions per minute. The armature is a gun-metal spider, and is wound with a thin steel ribbon paper insulated. The total floor space of two machines with their motor is 19 feet 9¾ inches × 4 feet 9½ inches. There will be nine such sets in the complete station. The low tension Edison network is fed from a battery fed at 125 volts by rotary converters, which receive current transformed down to 83 volts by static transformers fed by the 6,000-volt current of 25 cycles. The three static transformers are of 150 kw. capacity each, and are cooled by air-blast furnished by a 1-H.P. bipolar ironclad motor. The two rotary machines are each of 200 kw. capacity at 375 revolutions. Two induction regulators regulate the direct current voltage by variation of the 83-volt static secondary current.

The battery contains 156 cells, having a capacity for 10 hours of 1,200 amperes, or of 6,000 amperes for one hour. It is to act as a reserve in case of breakdown. The battery is fed from the Pearl Street station through a booster. It discharges simultaneously, and is at all hours connected to the low tension mains for purposes of regulation.

The operation in case of breakdown is simple, and consists simply in reversing the normal operation of the battery rotaries and transformers, the battery discharging to the rotaries, these delivering three-phase current to the transformers, which in turn deliver the necessary 6,000-volt current to the synchronous motors. The booster is a Churchward three-machine type, the end machines being dynamos of 1,000 amperes and 50 volts, and the centre machine is suited to run either at 125 or 240 volts, as required, according as the dynamos give their output at a low E.M.F. or high.

The brushes are of carbon, with surface contact sufficient to give only 20 amperes per square inch. The floor space is 12 feet 2 inches by 34 inches by 37½ inches high. The switchboard is 45 feet long, built up of 11 panels. The distribution board is in a fire-proof vault, and is in four panels, carrying quick-break switches of G.E. high tension type on corrugated hard rubber cones, separated from each other by high barriers of japanned maple. They are pulled open by a hooked stick.

Incoming current from the Union station is transmitted through three-wire duplicate lead-covered cables drawn through earthenware ducts. They are paper and compound insulated tested at 12,000 to 15,000 volts. Outgoing mains are carried underground.

The high tension series arc wires run underground for three quarters of a mile and are then carried on poles to the arc lights. During the transformation of the station not a single lamp was at any time put out of lighting.

REVIEWS.

James Clerk Maxwell and Modern Physics. By R. T. Glazebrook, F.R.S. The Century Science Series. London: Cassell & Co., Limited.

One cannot come into contact with the pupils and friends of James Clerk Maxwell and not be sensible of the singularly strong sentiments of devotion and respect that he inspired in his own generation at Cambridge. His acute intellect, and extraordinary insight into physical laws, his untiring, unremitting, and single-minded devotion to his work, and the immense strength of his conscience, had all a share in his influence over the minds of other men. Probably the last quality was of paramount importance in determining his position as something apart from other men of great intellectual ability. His view of life, expressed in a paper written at the age of 23 to the present Dean of Canterbury, and printed in this biography, shows that he possessed even at that age an exceptionally noble and well developed character. This account of his life, like the larger one by Prof. Campbell and Dr. Garnett, is eloquent of affection and admiration for its subject, not less than that of the pure mathematicians for their master Cayley, or of biologists for Charles Darwin. Clerk Maxwell's name is but the first and greatest of a great succession, and the school of physics that he founded is the glory of modern Cambridge. While politicians and administrators, historians and journalists, seem to be bred chiefly by the older university, the attack on the secrets of material nature, which is so striking a feature of the last half century, has received its chief inspiration in England from the Cambridge schools; and a new account of the life and work of their greatest teacher from the pen of a distinguished pupil, is necessarily of great interest. Mr. Glazebrook's account of Clerk Maxwell's life is condensed, so far as the biographical part is concerned, from the larger book by Campbell and Garnett. The account of his scientific work seems to be entirely new. Mr. Glazebrook is nothing if not scholarly and exact, and his attempt to describe for non-mathematical readers the work of a great mathematical thinker is probably as well done as is humanly possible. But it is not easy reading. Descriptions of a theory of colour vision without diagrams, and of molecular and electrical theories without symbols, may interest a reader and incite him to go further, but are not in themselves very satisfactory. It is, however, difficult to see how the work could have been better done on the same lines, and the book may be thoroughly recommended as well for its literary performance as for the interest of the matter.

The Discharge of Electricity through Gases. By J. J. Thomson, D.Sc., F.R.S. London: Archibald Constable and Co.

Prof. J. J. Thomson has dedicated to his audience a reprint, with additional material, of four lectures delivered at the University of Princeton, U.S.A., in October, 1896. This delightful little book of 200 small pages is an admirable summary of the experiments and speculations of Crookes, Lenard, Röntgen, Becquerel, Goldstein, the author, and others, on the subject of the title. The space is mainly occupied with descriptions of experimental results, references to the original papers being in all cases given in footnotes. In some places mathematical reasoning is used where a theory is to be reconciled with experiment, but, in the present stage of the subject, this is rarely possible. After describing some of the various means by which electrical charges can be given to gases, by chemical combination, by electrolysis, and by splashing, the author discusses at some length the great effect produced in the last case by minute additions of foreign, and especially fluorescent, substances to the dropping liquid. Proceeding then to the conductivity imparted to gas by the Röntgen rays, and by uranium, the author describes his own well-known investigation of the rate at which electricity can be conveyed by such conducting gases, and draws the apparently inevitable conclusion that the property is due to ionisation. Then after a discussion of the electrification of gases by metals exposed to ultra violet light, by the electric arc, by flames, and by red hot metals, the author gives Perrot's and his own beautiful experiments on the electrolysis of steam. The final chapter deals with cathode rays, and the theories of their nature. The whole subject, of course, possesses entrancing interest, and loses none in Prof. Thomson's hands. That it has pleased one of the acutest and most imaginative intellects of the present day to write a popular book on a new science, and one owing so much to himself, is a subject for warm congratulation, and we are grateful to him for it. We can heartily recommend it to our readers.

E

Modern Switchboards. By the Cutter Electrical and Manufacturing Company, Philadelphia, U.S.A.

This work, which consists of eleven chapters, describes the most modern forms of switchboard used in some of the largest electric power and lighting stations of the United States. The various devices for switches, circuit breakers and appliances, are fully dealt with and illustrated.

In introducing their work, the authors describe the earlier construction of switchboards as compared with those of the present day, and the forms of switch brushes and contacts such as are now more or less standardised in America, England and Germany, are well illustrated.

One of the chief objects of the book is to impress upon the readers the importance of using maximum automatic circuit breakers for the protection of their feeders from the power station. The authors very rightly point out that fuses for large currents are not reliable, inasmuch as they are often of such a section that a current 20 per cent. in excess of the current that is intended to blow them, will freely pass, that it is not reasonable to expect spools of fuse wire sold by the pound to be universally accurate, and that many conditions have to be taken into consideration, such as the temperature of the fuse terminals and their cooling effect, the conditions for dissipating the heat raised by the fuse, &c. Against these and other disadvantages is pointed out the promptness of action of the automatic circuit breaker which naturally leads up to the special form manufactured by the Cutter Electrical and Manufacturing Company, with a coloured illustration showing a side elevation with some of the working parts in section. Several photo prints are given of various types of this well known instrument, both single and double pole, up to 8,000 amperes. Another form of their instrument is illustrated for motor circuits taking up to 25 amperes at pressures up to 500 volts.

Lightning arresters are described and illustrated with, amongst others, a photo print showing the effect of a discharge of current through the old form of arcing device.

Switchboards and their construction for direct and alternating currents are dealt with at some length, with illustrations of either side of the boards. There are also several full size plates of large power station boards.

The authors are assisted by the contributions of Messrs. Luther Stieringer, Albert B. Herrick, W. H. Tapley and W. M. Scott.

The volume is beautifully illustrated throughout and much care has evidently been bestowed in compiling it. There will be found much of interest to central station engineers and switchboard manufacturers, although we see little in it that is particularly new.

Our modern station boards are much the same as those described, but perhaps a few differ somewhat from them. We like to see as much as possible on the front of the board, whilst they have their bus bars carried behind, a better plan, from the safety point of view, if plenty of room is available. It would be impossible to compare altogether our central station boards with those of America, for whilst they agree to a standard, our consulting electrical engineers generally have their own opinions as to design of boards and types of instruments and switches, according to special requirements.

Minimum circuit breakers for the protection of the generator circuit, are evidently thought little of in the States, whilst in this country it is certainly the rule to fix it for each machine before the circuit connects with the bus bars.

CORRESPONDENCE.

"Some Motors and a Moral."

In your article on this subject, the fact that Mr. Siemens estimates the cost per unit of electrical energy produced at his works at 2d. is taken as a proof that public electricity works could supply for motive power quite as cheaply as one could produce it for himself. How Mr. Siemens gets his cost up to 2d. per unit is a mystery.

Having been connected with many installations of electrical distribution of power in works, for some of which I have had careful accounts kept, I can say that the cost in most cases does not exceed that of the works' cost of producing at a public supply station. Why should it be otherwise? A works' manager can buy engines, boilers, dynamos, and coal in the same market as a borough engineer, and ought to be able to manage as well.

If 2d. a unit is to be the cost of electricity for motive power, then all that can be said is that very little electricity will be used either from a central station or elsewhere. 2d. per unit delivered at the switchboard means 2½d. delivered at the machines to be driven, a price which puts electric transmission out of competition.

Fortunately, however, those who use, and those who contemplate using, electrical distribution of power, may rest assured that they can get it from a good plant of their own for half that cost, and that, too, without the irksome restrictions laid upon them when using a public supply for motive power.

All the efficient managers, engines, boilers, and dynamos are not yet entirely monopolised by public supply stations, so that I trust we shall yet be able to do a little business in private installations.

Rankin Kennedy.

In this country wherever central stations have been erected for generating single-phase alternating currents, its application to motors for practical work have up to the present resulted in unadulterated failure.

In crowded cities its capacity for the manufacture of legal injunctions through the intolerable noise it creates, and its superior capacity for causing fatal accidents to workmen employed in its production, is everything that an ambitious lawyer of leisure could desire, but for a manufacturer who wants a safe motor to do genuine work quietly without fuss, none but a novice or lunatic would give it factory room where direct current for motors is available.

In fact, there is no need for "beating about the bush," the introduction of "single-phase high tension alternating current stations" into this country was a most unfortunate one, and, as subsequent events prove, a huge blunder.

For many reasons I denounced the system from the date of its introduction into this country, and I am now glad to note that several persistent advocates of the high tension alternating system for the electric lighting of towns in England are now advising the erection of central stations for direct current, besides central station managers in some instances are now obliged to provide direct current to consumers to prevent the possibility of loosing the usual 42 years monopoly.

Putting it shortly, to attain the best possible results for motors, arc lamps, enclosed and open, the direct current is an absolute necessity, and where there is a chance of supplying electric power for tramways single-phase high tension alternating currents are simply useless.

Bristol and its tramways is an example.

A. L. Fyfe.

A Treatise on Ozone.

Mr. Kershaw may write as much as he likes about ozone; I will no longer reply, but I can assure you that when my book on ozone is published, which, as usual, he criticises without knowing, the readers of the ELECTRICAL REVIEW will not be dissatisfied with the treatise written by your contributor.

E. Andreoli.

The Institution of Electrical Engineers.

Is this Institution, representing the latest and most important science of the age, becoming defunct, or what? There is not another institution of the kind that it might not copy with advantage. Beyond an annual conversazione, which is of little or no practical value, it never emerges from its deep slumber. Why not an Annual Meeting in some English or foreign town, with trips to leading manufactories? And why not issue official certificates of membership, as other scientific bodies do? Let the Council do these things, and keep out the men whose only qualification to membership is the capacity to twist a bit of wire with a pair of pliers, and the Institution will yet stand a chance of taking a leading position amongst its kindred associations.

Electrical Engineer.

Boosters.

I was very glad to see for the first time, a really good definition of "booster." A contemporary will probably tell you that you are wrong, but that does not matter.

But why do you leave out the alternating circuit? Would not an alternating transformer (of special design) connected in the way you show, have the same effect, namely, that of picking up the pressure to normal?

Is "booster" the name given exclusively to a special motor-generator, or is it given merely to a *contrivance* which is used for a particular *effect?* If so, the term might very reasonably be given to the transformer invention. By the way, a dictionary I have, says "booster" is a dynamo, &c.

E. R. Grote.

[Had we been writing an article on boosters instead of briefly replying to a question referring to boosters on a storage battery circuit, we should have described all their forms and applications, but replies to letters are necessarily brief and to the point raised; the name, of course, applies to transformers used for the same purpose on alternating circuits, in which case, M, in our diagram, is the primary, and, G, the secondary. Boosters can also be used to reduce the pressure by opposing E.M.F. Whether it would be proper to call them boosters in this case we, not being authorities on slang, cannot venture an opinion.—Eds. Elec. Rev.]

The Cost of Aluminium.

In reply to Mr. Steavenson, I should recommend him to buy up a waterfall, establish works, lie low, and await results.

If this statement is too Delphic, I would quote Mr. W. S. Gilbert, in *Ruddigore*. It says:—

> You mustn't hint
> In print.

V. Zingler.

THE POSITION OF DRAUGHTSMEN.

An article lately appeared in the *Engineer*, very sympathetic with the draughtsman, and bewailing his badly paid position. It has been followed by the usual crop of letters *pro* and *con* which always will follow when the position and pay of draughtsmen is broached. One of the arguments used against this drudge is, there are so many poor draughtsmen that the pay of the whole is brought down thereby. This is a poor argument which does not apply to other grades. Nine out of ten fitters and mechanics are poor and also very lazy, yet their pay is all placed at the level of the good minority. There are places where draughtsmen are well treated, and as one of our contemporary's correspondents states he has met them in Germany, where they are treated as professional men should be. But it is the rule to look on him as a mere drudge. Do not we all who have passed through the stage know how the chief would come in and bring some visitor and speak of my draughtsman in said draughtsman's presence as a mere chattel, and do we not all know how a carefully elaborated design is often spoiled by the unthinking soft-pencil criticism of the chief, who does that sort of thing to show his authority. Old draughtsmen are scarce. Either men leave the work, or they die young, this latter because they are not provided with proper drawing boards, or are so foolish as not to use them when provided. We question if many men enter a drawing office with the hope of remaining in it. They look on the duty as a passing phase of experience, and either leave it disgusted or get on to something better. There is, of course, a rank and file of draughtsmen, men of education and ability, who do not get out of the drudgery very soon, and yet who are sound engineers, and often the backbone of the works in which they labour. Employers speak to draughtsmen in a way they would not dare to speak to the most ordinary shop floor labourer, and the draughtsman has to put up with it or go. It is not always so however. Some of the best remembered scenes of an engineer's chequered life will be connected with the drawing office and its sundry rows and episodes. We remember—it must be nearly a quarter of a century since—how a 40 years' old draughtsman exhorted the present writer when a cub never to stay where he was apprenticed. He had done so, was now 40 years old, and had been reduced in pay for old age!!! Asked why he did not seek pastures new he declared he could not. He had never been anywhere but in this one shop, and had not courage to face the world outside its walls, so he stayed on and died at 45, a broken down old man, while the cub went and wandered to and fro on the earth and never at any time earned so little pay as this veteran draughtsman who knew every corner of the old shop, could put his hand on every pattern and name its use or history, had the dimensions of every part of every size of engine, and was worth ten times what he was paid had he had the courage to demand it. The cub in his wanderings found himself in a drawing office on the shores of the Pacific Ocean where the principal was wont to tear in and use swear words, and would throw his hat on the floor and dance thereon and howl that he was ruined. It was he who first taught swear words in a bad form to the cub who learned rapidly to throw them back at him, but that was only colonialism. In an Australian railway office occurred many scenes which are pleasant enough to look back upon now they are past and gone. The chief had the temper of a fiend and was absolutely fiendish in his manners to the engineering staff. He had several chief draughtsmen, none of whom could suit him until he got one who was not really a draughtsman at all, but rather an inspector of materials. This gentleman was accustomed to explain that he could get on with the chief because at home he had a brother-in-law with a liver and a fiendish temper, and understood the business of dealing with them. But there was one chief draughtsman who had notions of propriety. He wanted to insist that all the draughtsmen's sketches made in note books in the running shed and shops should be to scale, and as carefully figured as if for lithographic reproduction, and he would have done the same foolish thing by the drawings which were made by men of the Manchester school with dimension lines put in by hand slap dash. The last seen of this gentleman was in one of the office corridors, where, with back up, and hands on hips, like a cat on the tiles, he faced the chief engineer in similar attitude. Such was the description brought in by the one man who saw the awful sight; after that the culprit was seen no more. The same chief engineer discharged one of the draughtsmen because the latter had mildly hinted that a spark arrester was an obstruction to draught, but he reinstated him the same hour on finding that he had himself acted *ultra vires*, having no power to do otherwise than recommend dismissal, and he did this too, after little James had quietly asked him to put the discharge into writing, as being "more official, don't you know." But little James is there still, and the chief has been gone these many years, getting his first start off from our cub who also came into collision with the bad tempered one, and told him to his face in presence of all the staff a few home truths about sundry historical errors committed in the old country, and a few good rubs anent genealogy, and in the end the cub came out on top. These were fine times. A colonial office has its charms, one of which was a sort of communism. The office was never hard up as a whole. Individual members would be occasionally, and the others helped them out until their turn came, and there would be expeditions up the Parramatta River and down the harbour, and life was bearable even though the office was an inferno. We think that the act of sprawling over a flat board is conducive neither to the health nor the dignity of the sprawler, yet we are informed that at a works where vertical boards were tried to be introduced, the draughtsmen would not have them, which makes it appear that there must be draughtsmen of no more sense than common workmen. The proper drawing board is nearly vertical. It is balanced on hanging cords over pulleys at the top of a stout easel, and the tee-square is similarly a balanced angle bar hung by cords laced over pulleys. The flat part of the tee blade carries scale and pencil and light instruments. A similar shelf at the foot of the board carries other instruments, and the artist stands upright like a man. We are of opinion that a good draughtsman, one who is an engineer, needs to be bad tempered. If anything goes wrong, the blame is thrown

on him, even if what goes wrong has been altered from his design. "Do as you like, Mr. ——," we recently heard a designer say; "you are a partner here, but don't ask me to bear the responsibility of your alterations, and don't forget that I did not come here to learn engineering, and that if I did, no one here can teach me." This may not have been politic, but it was the way to stop officious intermeddling, and it is a pity more good men do not act thus more frequently in place of letting themselves be trodden upon, and then writing to the *Engineer* to complain.

Writing to the *Engineer* on draughtsmen's troubles has been going on for years, and no results have appeared. Too many managing engineers are getting half pay and running their department without friction, until their employers think they are doing nothing. It usually takes three men to bungle through the work of one such man should he throw up his job on some more than usually vexatious interference from the employer, and to lose such a man means the cost of a lot of new patterns as a rule.

In a huge works one man does not make much difference, as a large place can be run on routine lines, but in a small shop there is usually a lot of information carried in the head of one man and not in routine books, and his leaving is very awkward and costly. But, as a rule, the position of draughtsman in a small works may often be better than that in a large one, where the majority of the men are mere cyphers, of no account to their employer, and worse paid than shop floor labourers. It must, at the same time, be admitted that many draughtsmen are mere mechanics, and not engineers. In a locomotive works, for example, the engineering required is very small, and the work of the run of draughtsmen is merely that of slightly varying previous drawings and scheming in parts, and shall we use the word, "fudging" in curves. Fine as is a locomotive as a specimen of machinery, it represents very little engineering knowledge on the part of its designer, for there is no modern locomotive which is not simply the old "Puffing Billy" developed piece by piece during nearly 100 years. The engine of to-day is bigger by a mere trifle than that of yesterday. Its boiler is a little stronger, and none of these things are matters even for calculation, but simply the outcome of long years of practice. A part fails; it is made a little stronger. This same process is almost universal, and so it comes that draughtsmen are many, but the need of engineering knowledge in them is small. We have seen men who have passed through the shops and offices of large firms floored by the most elementary calculations of strengths. Such men, some of them, blossom out in time into full blown locomotive superintendents, which they are quite able to carry on satisfactorily, for they are good enough mechanics, and really do not even require to make serious calculations. The *Engineer* itself furnishes them with dimension drawings of the boilers for 160 lbs. pressure, and the same plate thickness serves them as serves others, and so they go on in safety, and finally die thinking themselves engineers, when all the time they are only mechanics.

But all men want to have a spell in the drawing office as part of their training, and probably this fact has much to do with the low pay. Good men will take a place at low pay because they don't mean to stick long at it. It is said that the position of chief draughtsman in one of the largest railway shops in England is only worth £200 a year, but that its occupier can always manage to go out somewhere, when he wants to do so, as locomotive superintendent, and once he is locomotive superintendent he has prospects of some day coming home and being one in England. The moral of all this is that men of particular education should keep out of the drawing office unless they can step out of it at their pleasure, and leave the work to the superior mechanic. We are convinced that there is a plethora of applicants for the office, and we are equally convinced that too often their treatment is such as no self-respecting man can put up with tamely. In some of the American shops the fact is boldly recognised, and the draughtsman is treated simply as a mechanic. Having no expectations of being treated other than as a unit, he perhaps suffers less disappointment. The opportunities for a poor man to prove himself an engineer and so get out of the rut are very few. His chances of making more than bare wages are infinitely less than if he could save enough money to buy a vice, a few chisels, and a hammer and file, and start doing small repairs in an iron shed or a wooden shanty. Had the present writer to live his life again he would purchase what he could every week until he had tools enough to make such a start. A man thus starting would find in time as he got on that his engineering knowledge would enable him to outstrip the perhaps more skilled mechanic, as opportunities would turn up of doing special jobs involving engineering knowledge. This knowledge sold to an employer of our draughtsman at most brings in a living wage, and there it is apt to end. The position of draughtsman is mistakenly looked on as a fine avenue whereas it is more often merely a blind alley.

ECONOMY OF DIFFERENT CRANK ANGLES IN STEAM ENGINES.

In a paper recently read before the North-East Coast Institution of Engineers and Shipbuilders, Mr. A. L. Mellanby describes very fully certain experiments made with the experimental engines at the Durham College of Science, with special reference to the effect of different arrangements of crank angles upon the economy of quadruple expansion engines. The following two arrangements were tried:—

Assuming the H.P. crank to be leading, it is followed at equal angles of 90° by the second, third, and fourth cylinder in turn, the cranks passing a given point in the order 1, 2, 3, 4. Each cylinder thus commences to exhaust when the next cylinder has its crank 90° in front. The arrangement, in fact, allows one cylinder to exhaust into another cylinder, the piston of which is at mid-stroke; and obviously this arrangement renders it desirable to cut off steam in the next following cylinder always before mid-stroke, so as to avoid a hump at the middle of the upper boundary of the diagram. The system also demands some receiver volume, in order to provide space for storing the steam pending the opening of the valve of the cylinder next following. In any case there must be more or less of bottling up of steam, and a hump in the exhaust line of the discharging cylinder.

In the second arrangement of cranks, the order of rotative sequence is 1, 4, 2, 3. With this arrangement, the first and second pistons move simultaneously, and No. 1 exhausts to No. 2 freely, and at no risk of bottling up pressure. Similarly No. 3 exhausts direct to No 4, their pistons both being at the end of their stroke at the same time. Only between Nos. 2 and 3 is the 90° position inevitable. This second position approves itself to most experienced engineers, we believe, as affording the better facilities for arranging steam distribution. It is open to question if the receiver in a compound engine is a very desirable accessory. It appears necessary in a two-cylinder compound to enable diagrams of good form to be obtained, but it is more or less of a heat waster, and unless made as a re-heater we question if its artistic effects are not frequently obtained at too high a cost of heat. The engines at the Durham College have cylinders 7 inches, 10½ inches, 15½ inches, and 23 inches in diameter respectively, with a common stroke of 18 inches. They are arranged so that the cranks can be coupled at different angles by means of bolted couplings. The boiler pressure is 210 lbs., but other trials were made down to 70 lbs. The H.P. cut-off being at 12 inches, the total expansion was 17·4. The vacuum was maintained at 24 inches, and the speed at 140 revolutions. As the only true basis of commercial economy is the brake H.P., Mr. Mellanby has given his results on this basis both in tabular and diagrammatic form, but it is to be noted that with the 180° crank arrangement both the water per B.H.P. and also per I.H.P. is less than with the 90° position.

This is what one would anticipate, and it is very marked. Also—curiously enough—the ratio of brake to indicated power is better, *i.e.*, larger, with the cranks at 180° than at 90°, which is to say that the mechanical efficiency is better.

So far as an even turning effort at the crank pin due to steam pressure is valuable the 180° position has the advantage, the range of effort varying between 27 and 38·7, as against 26·5 and 38·4, and the variations in the course of a revolution being also fewer. Perhaps there is no feature of an engine has held in thrall the mechanical engineer so much as the 90° angle for cranks. It is not so very long ago that all engines were single and ran at 18 or 20 revolutions, and the making of engines in pairs was very naturally accompanied—both engines being simple—by the 90° crank position. It was also accompanied by higher speeds and by heavier fly-wheels, on the principle, we suppose, that if a 10-ton wheel was required for one engine, then two engines required 20 tons.

As a fact, the old fly-wheels were too light, and the speeding of engines from 20 revolutions to 30 more than doubled the fly-wheel energy, as well as increasing the number of impulses per minute, while the impulse stress, due to higher steam pressure, was counterbalanced to some extent by the inertia effects of the moving parts. The thoughtless attributed all the benefits of steadier turning to the one item of right-angled cranks, and the error has stuck to this day, despite the many large single cylinder engines of Hick Hargreaves more especially, and the few cases where cranks of compound engines have been placed at 180° to secure the better distribution of steam thereby possible. In conversation with an

engineer of large experience, he assured us that with compound engines of variable cut-off he had been able to find a cut-off position for the L.P. cylinder, which was best for all grades of cut-off in the H.P. cylinder. This showed him that it was not necessary to vary the cut-off in both cylinders at once, but to work the L.P. cylinder at a constant fixed rate. It is undoubtedly true that what the Americans call "monkeying" with steam distribution may easily be over-done. Some small drop of pressure at the end of the H.P. stroke may be economically allowed without striving to carry the steam line of the H.P. diagram to the point from which the exhaust line commences, as may, of course, be done by the screwing up of the L.P. cut-off, and bottling up of the steam between the two cylinders. This sort of steam worrying may easily be carried too far. While we would not make the H.P. cylinder simply a measuring pot to parcel out steam to the L.P. cylinder as in the Woolf engines, we would not forget that some of the economy of compounding is due to the interception of leakages by the L.P. valves and cylinder, and that it is undesirable that the large piston of the L.P. cylinder should have too great a difference of pressure on its two sides. The experiments described in the paper are all in favour of the more simple methods of work. The results obtained are, of course, particular, being from a given set of engines, and we are not entitled to claim their general application. At the same time they seem to be reasonable, and they serve to endorse opinions formed in general practice, and there is nothing to show why the arrangement giving the better results should not always be better while there is the fact to indicate that it may be better in all cases.

LONDON COUNTY COUNCIL.

The London County Council resumed business on Tuesday, when it was obvious from the proceedings of the Highways Committee that the latter had taken full advantage of the power of acting in the place of the Council during the recess.

Transfer of Electric Lighting Powers.

The adjourned report of the Local Government Committee was submitted in reference to the resolutions passed at the conference of London local authorities held some time ago. One of these resolutions was, "That the powers of the Council under Electric Lighting Provisional Order Confirmation Acts, as regards the appointment of inspectors, provision of testing stations, and exercise of powers with reference to price and energy of the supply of electricity in a district, should be transferred to the local authorities."

The Local Government Committee expressed the opinion that it was most essential that these powers should be exercised by one authority, having regard to the additional cost that would of necessity follow a transfer of the powers to the local authorities, in connection with testing stations and plant, and also having regard to the necessity of a general supervision and uniformity of treatment in these matters which involve more than local interests.

The Committee accordingly recommended that such powers should not be transferred to the local authorities, and the Council, without any debate, adopted the view set forth by the Committee.

Rental for Use of Subways.

Among the long batch of approvals of street works by the Highways Committee, attention may be drawn to the following "extra conditions," imposed upon the Charing Cross and Strand Electricity Supply Corporation in the case of the two streets mentioned:—

"That the mains for Charing Cross Road and Shaftesbury Avenue be laid in the subways there, and that the company do pay rent in accordance with the scale laid down by the Council in respect of the user of such subways; that the positions to be occupied by the mains in the subways be subject to the approval of the Council's chief engineer; that the work of placing the mains be carried out and any damage that may be done to the subways in the execution of the work be made good to his satisfaction, and at the cost of the company."

Similar additional conditions were imposed upon the Metropolitan Electric Supply Company in regard to works of main laying in Shaftesbury Avenue, Charing Cross Road, and Garrick Street.

Other Extra Conditions.

In addition to the usual conditions, the Highways Committee insisted on the fulfilment of the following stipulation in the case of mains proposed to be laid by the London Electric Supply Corporation in various thoroughfares:—

"That the high tension mains be placed at least a foot lower than those of low tension, or if the mains cannot be laid at that depth under the footway they be laid in the carriageway; that separate boxes be used for the high and low tension mains respectively, or adequate precautions be adopted, to the satisfaction of the Council's chief engineer, to keep the mains apart in the boxes."

Electric Supply in Greenwich.

It appeared from the report of the Highways Committee that two notices has been given by the Blackheath and Greenwich District Electric Lighting Company of intention to lay mains in Blackheath Road and Lewisham Road from Deptford Bridge to the boundary of the Greenwich district, and to lay mains from the boundary of the Greenwich parish along Lewisham Road and Hill, Aberdeen Terrace, Haddo Villas, and Eliot Vale and Place. The company had also submitted six other plans, giving full details of the proposed works. It appeared that the intention of the company is to obtain from the London Electric Supply Corporation's mains at Deptford Bridge the supply of electrical energy for the areas referred to in the notices.

As the adoption of this course, in the opinion of the Highways Committee, seemed to be inconsistent with the provisions of the order, the Committee stated that they had formally disapproved the proposed works, and had instructed the solicitor to report upon the questions involved.

Extensions of Electricity Works.

It was decided to approve plans submitted on behalf of the Vestry of Hampstead for an addition to the generating station in Lithos Road, and to also approve plans presented by the Metropolitan Electric Supply Company for an extension of the works in Amberley Road.

New Dynamo Works.

The Council further decided, subject to the provisions of Section 76 of the London Building Act, 1894, to consent to the erection on the south side of Harrington Road, Woolwich, of a building to exceed in extent 250,000, but not 450,000 cubic feet, and to be used only for the purposes of the manufacture of large dynamos and alternators, as shown by the plans submitted with the application of Mr. A. Sabine, on behalf of Messrs. Siemens Bros., such consent being, however, subject to the following conditions:—That the whole of the work be carried out to the satisfaction of the district surveyor; that if the said plans, particulars, or application be hereafter found to be inaccurate in any respect, the said consent shall be null and void.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Oct. 4th, 1897.	£	s.
Adelaide	24	0
Amsterdam	40	0
Batia. Teleph. mat. ...	475	0
Boca	10	0
„ Teleg. mat. ...	309	0
Calcutta	82	0
Cape Town	948	0
Colombo...	10	0
Durban. Teleg. mat. ...	65	0
„ Teleph. mat.	30	0
East London	215	0
Fremantle	42	0
Gibraltar	255	0
Gothenburg	288	0
Halifax	27	0
Hiogo	43	0
Hong Kong	171	0
La Guayra	57	0
Leghorn	10	0
Madras	133	0
Malaga	24	0
Melbourne	1,276	0
„ Teleg. mat.	138	0
Naples	136	0
Passages...	480	0
Port Elizabeth	723	0
St. Petersburg. {Teleg. / mat.}	25	0
Singapore	42	0
Stockholm	16	0
Sydney	379	0
„ Teleg. mat. ...	731	0
Tientsin	6	0
Timara	9	0
Trieste. Teleg. mat. ...	95	0
Total	£7,314	0

Week Ending Oct. 4th, 1898.	£	s.
Adelaide	20	0
„ Teleg. mat....	820	0
Aden	29	0
Amsterdam	102	0
Boca. Teleg. mat. ...	566	0
Bombay	10	0
Boston	40	0
Boulogne	37	0
Buenos Ayres	28	0
Calcutta	239	0
Cape Town	1,718	0
Cologne	367	0
Demerara	51	0
Durban	297	0
„ Teleg. mat. ...	248	0
East London	207	0
Fremantle	375	0
Gothenburg	37	0
Halifax. Teleg. cable	26,000	0
Hong Kong	185	0
Monte Video. Teleg. wire	407	0
Ostend	20	0
Para. Teleg. cable ...	9,000	0
Perth	125	0
Port Elizabeth	128	0
St. Petersburg. {Teleg. / wire}	178	0
Stockholm. Teleg. wire	24	0
Sydney	2,653	0
Yokohama	281	0
Total	£44,174	0

Foreign Goods Transhipped.

	£	s.	d.
Boulogne	22	0	0

	£	s.	d.
Durban. Telephone	30	0	0

Amendment of Patent.—From an announcement in our "Official Notices," it will be seen that Messrs. J. F. Bachman, A. Vogt, J. Kirchner, A. König, C. Weiner, and A. Jörg, all of Vienna, are applying for leave to amend the specification of their patent No. 15,238, of 1897, for "an improved manufacture of electrical resistances." Notice of opposition must be given within one month.

Auction Sale.—Messrs. Percy Huddleston & Co. will sell by auction on Wednesday, October 19th, a vertical compound condensing engine, a marine boiler, condenser feed pump, trucks, &c., &c., which are to be disposed of on account of the removal of the generating station of the Brighton and Rottingdean Seashore Tramroad to Kemp Town. See our "Official Notices" this week.

Books Received.—"Second Stage Mathematics," edited by Wm. Briggs, M.A., &c. W. B. Clive, University College Press, London. 3s. 6d.

"General Elementary Science," second edition; edited by Wm.

Briggs, M.A., &c. W. B. Clive, University College Press, London. 3s. 6d.

"The Telephone: Outlines of the Development of Transmitters and Receivers." By W. J. Hopkins. Longmans, Green & Co., London. 3s. 6d.

Bankruptcy Proceedings.—*Re* H. D. McIntyre, of Putney, S.W., and Glanamman Colliery, Glanamman, Carmarthenshire, colliery proprietor and electrical engineer. The statutory meeting of the creditors concerned under this failure was held at the offices of the Official Receiver, Swansea, on Monday. The statement of affairs filed by the debtor, disclosed gross liabilities amounting to £4,984 5s. 4d., of which £3,879 13s. 6d. was expected to rank against the estate for dividend. The assets, including the debtor's interest in the lease of the colliery valued at £1,600, were returned at £3,093, from which £319 11s. 11d. have to be deducted for the claims of preferential creditors payable in full, leaving net assets at £2,774, and a deficiency of £786 4s. 6d. It was resolved to appoint Mr. A. B. Davies, accountant, of Swansea, as trustee, to act in conjunction with a committee of inspection.

Catalogue.—Mr. Albert C. Hands, of Garlick Hill, E.C., has just issued a priced catalogue of his electric light fittings and glass and silk shades. There is a large variety of brackets, pendants, electroliers, standards, and bronze figures illustrated therein.

Changes of Address.—The registered offices of the Newcastle-upon-Tyne Electric Supply Company, Limited, have been removed from Pandon Dene to 50, New Bridge Street, Newcastle-upon-Tyne.

Owing to their premises being required for the widening of Parliament Street, Messrs. A. and W. Hopkins have taken fresh premises in "Clun House," Surrey Street, W.C.

Messrs. W. T. Glover & Co. have removed their London offices from 39, Victoria Street, S.W., to "Dartmouth House," Queen Anne's Gate, Westminster, S.W. All communications should be sent to the new address.

Messrs. Mendham & Co. (late King, Mendham & Co.) have removed from 10, Victoria Street to larger premises at 1 and 2, Quay Head, and Stephen's Avenue, Bristol.

The Penny-in-the-Slot Electric Supply Syndicate, Limited, has removed from Parliament Street to Bartholomew Works, end of Lawford Road, Kentish Town, N.W.

Companies struck off the Register.—In last Tuesday's *London Gazette*, the Assistant Registrar of Joint Stock Companies gives a list of the companies whose names have just been struck off the register, and are accordingly dissolved. The following appear among them:—

Automatic Electric Sign Company.
British Horseless Carriage and Motor Cycle Company.
Canterbury Electricity Supply Company.
Cycle and Motor Car Improvement Corporation.
Electric and Automatic Engineering Company.
Electric Guest Call Company.
Electric Light Regulating Syndicate.
Electric Time Distributing and Clock Company.
Electro-Mechanical Photographic Syndicate.
Gloria Electrolytic Incandescent Light Company.
"Harp" Arc Lamp Syndicate.
Knoeferl-Bonn Dental and Electrical Manufacturing Company.
Manchester Suburban Electric Supply Company.
Pioneer Syndicate of the Capital and Counties Electricity Supply Company.
Silicon Electric Lamp Syndicate.
Town and Village Electric Light and Power Company.
West Australian Electrical Trunk Power and Lighting Company.

Dissolution of Partnership.—Messrs. L. M. Engel and H. A. Marler (Engel & Marler, electrical engineers), 48, Fore Street, E.C., have dissolved partnership by mutual consent.

Electric Locomotives.—Some trials with an electric shunting locomotive, built by Messrs. E. Klemm & Co., of Dresden, have lately been carried out at the goods station at Königstein, Germany.

Electric Heating.—Messrs. Bergtheil & Young send us a list of their electric heaters of the H. W. Johns Manufacturing Company, stating their main features and advantages for street car heating, and giving sketches of the various classes of apparatus. There are remarks made on the regulation and wiring connections for these heaters, directions for installation, and diagrams of connections for panel heaters. The heater regulating switch is described. A French and German list, very similar in its contents, is also published.

Electrical Finance.—La Società Italiana per Applicazioni Elettrichi is the name of a new company which has been formed at Turin with a capital of £160,000, to promote and finance electrical installations of all kinds.

Electricity for Pumping Purposes.—Mr. G. B. Marten, in his monthly report to the South Staffordshire Mines Drainage Commissioners, remarks as follows respecting the prospects of the Midland Electric Corporation for Power Distribution being established in the district:—"The prospect of the establishment of a public electric power company, with wires for distribution over the whole district to supply electric power at a low rate at no distant period had offered a practical means of dealing with the low areas from which water was known to escape into the mines. The whole surface had again been fully examined, and 50 sites for electric pumps had been selected as suitable for the purpose, and levels had been carefully taken to note how branches could be extended from the nearest repaired brook courses to take the water safely away from the pumps. Somewhat in anticipation of the help of electric pumps, the surface works in various places had been so far extended towards some of the selected sites for pumps."

Extension of Premises.—Mr. J. W. Barrard, of Great Winchester Street, E.C., states that, in order to meet the increased demand for E.P.S. small storage cells (Q. and V. type) he has acquired additional premises at 13, Brownlow Street, Holborn, W.C. The premises will be equipped as a warehouse and factory for repairs, and charging cells, and an adequate stock will be kept.

Extension of Works.—The firm of Messrs. J. P. Hall and Co., electrical engineers of Werneth, Oldham, have recently had their works enlarged to about twice their normal size, in order to meet the great increase of business that the firm now enjoys. The "old" part of the works was erected less than 10 years ago.

Fire.—A fire recently broke out upon premises adjoining those of Mr. G. Braulik, of 217 and 218, Upper Thames Street, E.C., but though Mr. Braulik's goods were considerably damaged by water there will be no delay in the execution of orders, as Graham Wharf was used as a store only.

The Institution of Junior Engineers.—On Saturday, 24th ult., a party of about 100 members of this society availed themselves of the opportunity kindly afforded by Sir David Salomons, Bart., to inspect his engineering workshops, laboratories, lecture theatre, &c., at Broomhill, Tunbridge Wells. The numerous scientific instruments, and special appliances employed for electrical and other experiments were examined with evident appreciation. Sir David showed the members the general mode of working with them, and in many other ways devoted himself to rendering the occasion interesting and enjoyable, for which, at the conclusion, Mr. H. B. Vorley, the chairman, expressed the cordial acknowledgments of the Institution. Sir W. H. White, F.R.S., is to deliver his presidential address on Friday, October 21st.

Insulating Compounds.—Messrs. Laing, Wharton, and Down, Limited, have recently taken up the exploitation for this country of a special line of insulating compounds for the various purposes connected with electric lighting and transmission of power. They are three in number, viz.:—No. 1. *Armalac.*—This, we are informed, is a very high-class compound, derived from petroleum by special method of refining at very high temperatures (1,500°) and under pressure, and it should be impossible to find in armatures or field magnets anything like the heat which this varnish is claimed to stand with ease before melting, viz., 500° Fahr. As most lubricating oils are of the same class, being derived from petroleum, they have absolutely no reaction on this varnish such as takes place where the copal or shellac styles of varnish are used. Indeed, the latter, it is well known, are apt to form chemical combinations with lubricating oils, thereby releasing resin acid, which is almost as dangerous to armatures as sulphuric or other free acids. This result may often be seen by the green colouration, due to salts of copper, which is the consequence of using compounds which are so ill-designed for these purposes of high insulation. On the other hand, should lubricating oil reach armalac insulation it simply tends to make it temporarily slightly more plastic than is its usual constituency. For it is claimed a permanent plastivity under all conditions (except that of excessive cold which does not occur with running dynamos); and, therefore, in driving on coils or bars insulated with armalac, whether for field magnet or armature building, the installation will not crumble and break away as with ordinary varnish. "Armalac" is used very largely in the most important works in America and Europe, and by a number of the principal dynamo makers in this country. No. 2. *Enamelac.*—This is for special use where ordinarily compounds of asphaltum and other heavy bodies are used for electric light station use, and also electric railway and traction work, such as painting bonds, covering joints, that may be exposed to varying temperatures, for accumulator racks and other rougher work than that for which the use of armalac is recommended. No. 3. *G. E. Cement.*—This cement has been specially designed for sticking together, in sheets, the various layers of insulation used in connection with the building of dynamo machines, stationary and electric railway motors, transformers, and other electrical apparatus, and it is stated to have been found to fill a very considerable want, for when ordinary varnish is used for holding these various things together, cutting or stamping cannot be done without crumbling, which is a very undesirable state of things.

Liquidation Notices.—The Tramways Electrical Traction Company, Limited, will meet on November 4th at 7, Poultry, E.C., to hear an account of the winding up from Mr. J. B. Glenn, liquidator.

On November 2nd, a meeting of the Morecambe Electric Light and Power Company, Limited, will be held at the King's Arms Hotel, Morecambe, to hear Mr. C. R. Compston's account of the winding up.

Mica and Micanite.—Messrs. Bergtheil & Young, of Camomile Street, E.C., who are the sole agents for Europe for the Mica Insulator Company of America, have sent us a copy of that company's latest catalogue dealing with mica and micanite insulation specially adapted for railway motors, generators, &c. The book opens with some interesting notes on the mica mines of India, and the treatment of the material. Some comments on the physical properties of an insulator are followed by tabulated figures giving the insulation of micanite and other insulators per centimetre and per cubic inch, also the potential necessary to break down the different thicknesses of insulators, and the specific resistances of various fibres. The construction of commutators is considered, and particulars are given of some of the micanite commutator segments now being manufactured At the end of the book we find several pages giving data of the

micanite commutator insulation for various standard types of railway motors. The trade in refilling commutators in America is an extensive one, and will probably increase in Europe.

The Optical Exhibition. — At Stand No. 37 at the above exhibition at the Mansion House, Messrs. H. W. Cox, Limited, of Cursitor Street, have been exhibiting some of their well known X ray apparatus. It is gratifying to note that the whole of the apparatus is manufactured in their own works.

"Sappho" Arc Lamps. — We have received from Messrs. Foxcroft & Duncan, of 24, Queen's Road, Dalston, N.E., particulars of their "Sappho" enclosed arc lamp for direct or alternating currents. The lamp is constructed to burn direct current 130 to 160 hours with one pair of carbons and without attention. It is made with compensating resistance in the cover. It has no rack, no clockwork, no cords, and no chain, and has but one moving part. The globe is so arranged that it can be lowered and left hanging while the lamp is being re-carboned. The alternating lamp is of the same type, suitable for burning on 100 volts across the terminals, and needs no outside choker as required by many other lamps.

To Creditors.—All persons having claims against the estate of John Thomas Gent, lately residing at 12, Brighton Road, Moseley, Birmingham, retired electrician, deceased, are required to forward particulars of the same to Messrs. Whetstone & Frost, Town Hall Square, Leicester, forthwith.

Release of Trustee. — The *London Gazette* contains notice of the release of trustee (Mr. H. W. Cox) on June 29th, in the case of Geo. Thompson (trading as G. Thompson & Co., electrical engineers, Queen's Road, Brighton).

Wiring Work at Canterbury.—In consequence of the installation of the electric light now in progress, Mr. W. Attwaters has opened premises at No. 2, Lower Bridge Street, in that City, as electrical and mechanical engineer. Several tradesmen have opened an electrical engineering department in conjunction with their other businesses, and are securing good orders. So popular is the scheme that it is thought that it will have to be enlarged almost immediately.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Operations have now been practically completed for bringing the electric light within reach of a large portion of the residents in the west end of the city.

Asylum Lighting.—The Asylum Visitors Committee of the Radnorshire County Council consider that the best method of lighting the proposed new Asylum will be by electricity, and they have obtained a report from the architect on the subject. The Council has decided to adopt this method of lighting.

Barking.—The District Council has resolved that Messrs. Alexander, Penny & Co.'s tender for free wiring, at 7s. per point, including points for more than one light, or for arc lamps, be accepted, and the clerk has been instructed to prepare an agreement with them. The surveyor reported that since the last meeting but moderate progress had been made with the erection of the electric light station. The contractor was now proceeding with the excavations for foundations to the engineering plant. Some little delay had arisen with the boiler room outside wall, owing to the position of the boilers not suiting the openings shown on the original drawing. This would necessitate some slight alteration to the boiler room, which he hoped to settle with the electrical engineer that week. He had been into the question of raising the shaft with the engineer, and they were of opinion that it was not practicable. The chairman said that they were working hard to have the light in November.

Barnsley.—The borough surveyor has been instructed to advertise for tenders for the various works required in connection with the electric lighting scheme.

Bath.—One of the assistant engineers at the electricity works having resigned, the Committee is proceeding to fill the vacancy. Last Friday the first of the new machines was put into use and ran three or four hours. Consumers are asking for a reduction in the charges for current.

Bolton.—At the Town Council meeting on Wednesday, there was a lengthy discussion as to the proposal of the Electricity Committee to advance the salary of Mr. Arthur Ellis, the electrical engineer, from £300 to £450 per annum from October 1st, and during the equipment of the tramways for electric traction. Some feeling was imparted into the matter by two so-called labour representatives because the Council on a division just taken previously had refused to give an advance in wages to the street sweepers. Councillor Jas. Holt opened the discussion by moving an amendment to the effect that the advance to Mr. Ellis be £100 and not £150 per annum. On a division only six voted for the amendment, 43 being against. The recommendation was, therefore, confirmed by an overwhelming majority.

Bournemouth.—There was a main box explosion in Holdenhurst Road on 26th ult.

Brierley Hill.—At Monday's District Council meeting, the Lighting Committee reported that a communication had been received from the Midland Electric Corporation for Power Distribution, explaining their object in applying for a provisional order, and suggesting that the representatives of the Corporation and of the Committee should meet and discuss the question. The Committee agreed to arrange such a meeting. Mr. F. G. Cooper said they had been getting all the information they could, and hoped in a few days to lay a tangible electrical scheme before the Council. It was agreed to meet deputations from the Midland Electric Corporation and from the Dudley and Stourbridge Electrical Company.

Canterbury.—At the last Council meeting the town clerk was instructed to ask the engineer to obtain designs for the incandescent lamp posts and fittings, and to prepare specification for wiring the works. Among other arrangements it was decided that the telephone company be approached with a view to a general contract being entered into for connecting the public offices of the city, including the electricity works, and that the Corporate seal should be affixed to the agreement with the National Free Wiring Company. On 21st ult. Mr. Hammond reported to the Lighting Committee on the progress of the works, buildings, plant, &c. There is every prospect of the works commencing running before 1899.

Chelsea.—The Vestry, it will be remembered, asked the Board of Trade to reconsider their decision not to grant a provisional order, but the Board replies that its decision was given after very careful consideration, and it could not be altered. The Board pointed out with respect to the provisional orders granted to the Vestries of Bermondsey and St. Marylebone, that, although there was only one company in each of those parishes authorised to supply electricity, the Board felt considerable hesitation in granting the orders, and only did so with the view of giving Parliament an opportunity of deciding whether powers to compete with the existing companies should be granted; and that, in the case of St. Marylebone, where the existing company have exercised their powers to a considerable extent, Parliament has refused to confirm the order granted by the Board.

Cheltenham.—The Town Council has resolved that, for the purposes of entertainments, the Montpellier Gardens shall be lighted by means of coloured electric lamps placed in festoons along the boundary of the outside paths at a cost not exceeding £1,000. Plans and estimate were prepared by the electrical engineer.

Chiswick.—At a recent District Council meeting, says a contemporary, the clerk reported that Messrs. Kincaid, Waller and Manville, the engineers to the Aberystwyth and Chiswick Electric Supply Corporation, had written giving notice of their intention to commence laying mains in the High Road, from the east corner of Turnham Green to the boundary between Chiswick and the Hammersmith parish, in a month; also that they contemplate using the low tension three-wire system. It was decided to inform the engineers that their notice was invalid.

Cork.—The scheme of electric lighting which is combined with the electric tramway system is being largely availed of by both shopkeepers and householders in this city. Almost all the principal shops are now lighted electrically, and a number of private residences also. The public lighting of the streets by electricity is rapidly progressing, and before many days have passed the chief business thoroughfares will be electrically lighted. The electric trams are expected to be running shortly, as the poles are in position, and the work of overhead wiring is progressing rapidly. The different firms of electrical engineers have their hands pretty full of work at present.

Doncaster.—The Council has resolved to proceed with the electric lighting scheme, and Mr. Shoolbred has been engaged to act as consulting engineer.

Dublin.—The *Daily Nation* says:—"We understand that attention is to be called in the Corporation this week to the fact that the new Dublin electric cable supplied to the Corporation in substitution for the one which had worn out and caused the recent failure of electric lighting in the city, is not in accordance with the specification. It was passed and laid down, we understand, by the English expert brought over by the Town Council, and this gentleman, on being called on for an explanation, insists that, although differing from the specification, it is really better than the one specified for. The Electric Lighting Committee, feeling that they have no power to call on the contractor to rip up the new cable, intend to refer the whole matter to the Council, and some feeling has been aroused amongst members as to the course that should be taken under the circumstances."

Durham.—On Wednesday the City Council resolved, upon the Electric Lighting Committee's recommendation, to apply for a provisional order, and to hold a special meeting to further consider the matter. At that meeting a report will be submitted by Mr. W. C. C. Hawtayne upon a scheme for the city.

Eastbourne.—At a meeting of the Town Council on Monday the Mayor (the Duke of Devonshire) presiding, a committee recommended the Council to take over the lighting of the borough by electricity. Alderman Pocock moved the adoption of the report, and Councillor Simmons, in seconding, said the committee felt that the lighting should in future be in the hands of the local authority. They were not antagonistic to the present electric lighting company. What they proposed to do was to light the whole of the streets and the municipal buildings. They now paid annually £5,923 for lighting, and they claimed that they could produce the electric light and effect a saving equal to a 1½d. rate. They not only provided for a sinking

fund, but they estimated that they would be able to place £750 annually as a depreciation fund reserve. Councillor Breach suggested that they should have more time in which to consider the proposal. He proposed that it be deferred for a month, and that in the meantime the electric light company be approached as to what they would be prepared to sell the undertaking for. Councillor Hillman asked what there was to wait for. If they did not proceed at once they would not be able to get a provisional order until 1900, and it would be 1901 before they could do anything. He suggested that they should go to the company and ask them to sell, and if they preferred to enter into competition, let them compete. First of all, however, let them try to purchase from the company on fair terms. The town clerk, in reply to the Mayor and other members, said it was necessary to give the notices for a provisional order during two weeks in November, and if the Council deferred their decision until the final meeting on the 24th of this month, it would be early enough. After further discussion, the amendment was negatived by 14 votes to 8, and the committee's recommendation adopted.

The above refers to a report presented by Mr. Hawtayne, in which three schemes were given: scheme 1 being for a steam raising plant combined with a remodelled destructor; scheme 2 for steam raising plant without destructor; and scheme 3 for a similar undertaking worked by a destructor only. The committee's recommendation to the Council was that scheme 1 should be adopted.

Edmonton.—The District Council has so many things in hand, that it will not apply for a provisional order this session. It will, however, oppose the large scheme of the North London Electricity Company, but would be prepared to consider a joint municipal scheme.

Exeter.—The Electric Lighting Committee recently ordered an additional 24 kw. transformer from the Brush Company for £58. The Committee reports to the Council that, since the last meeting, 18 new consumers with 789 8-C.P. lamps had been connected, and there are 20 consumers with 700 8-C.P. lamps waiting for connection. The electrical engineer recently reported upon the working of the arc lamps. The consent of the Local Government Board had been given to the borrowing of the sum of £7,000 for extensions.

Friern Barnet.—In preference to the scheme of the North London Electricity Company, the District Council favours a joint scheme by the various local authorities.

Greenock.—The applicants for the post of electrical engineer were reduced to three, and Mr. S. E. Fedden, of Edinburgh, was chosen to appear before the Law and Finance Committee.

Hendon.—Messrs. Merry and Hearn, who recently represented the Hendon District Council at the conference of local authorities interested in the scheme of the North London Electric Light Company, say that the conference was a "frost." Mr. Merry says that the scheme of the company is preferable to that suggested by the Enfield District Council. He advised the Council not to go any further in the matter, and this course has been agreed to.

Huddersfield.—There was a slight failure in the electricity supply last Saturday night.

Hull.—Last week the Electric Lighting Committee accepted the tender of Messrs. Newton & Chambers, Sheffield (£473), for an iron roof in connection with the extended portion of the electricity works in Sculcoates Lane. Mr. Good's tender (£2,532) for the extension of the station buildings has also been accepted. The opening of the station in Sculcoates Lane is to take place on 20th inst.

Ilford.—Mr. Hawtayne was present at a Council meeting at Ilford on September 28th, for the purpose of discussing the question of tramways and electric lighting, and was then instructed to prepare all necessary specifications and plans for a combined system of tramways and electric lighting for the district. The tramways will form the more important portion of the contract, as it has been decided to equip in all between 16 and 17 miles of line, a part of which will be double track.

Ipswich.—Messrs. Crampton & Co., of Great Yarmouth, have just completed an electric light installation at "Friendly House," Ipswich, the premises of Messrs. Edward Brand & Sons, drapers. The installation includes a Crossley's 32 H.P. electric light high speed self-starting engine, and one dynamo of 300 lights. Throughout the premises from 200 to 300 lamps may be lighted at one time. Two 1,500-C.P. arc lamps light the outside of the shop.

Keighley.—The Town Council last week resolved to apply for electrical powers, and Alderman Paget said that the Committee were very much in earnest about carrying a scheme through.

Kendal.—The further consideration of the report on electric lighting prepared some time ago by an expert, has been deferred until the report of Mr. Silverthorne on the question of gas extension has been received.

Lancaster.—Messrs. Calvert & Heald have almost completed the installation of the electric light in the Centenary Congregational Church, Stonewell, Lancaster. The demand for electric light in business premises as well as public buildings, has become so general that the Corporation have decided to extend the plant.

The Town Council last week resolved that application be made to the Local Government Board for £20,000 for the extension of electric lighting and other purposes.

Leeds.—At a meeting of the Parliamentary Committee last week, clauses to be embodied in a Bill to be introduced next session with reference to the purchase of the Yorkshire House-to-House Electricity Company's property by the Corporation were under consideration.

Leicester.—We were only able to mention the electricity accounts very briefly last week. We now give the statement at greater length. On September 27th Alderman Lennard moving at the Council meeting the adoption of the half-yearly financial statement of the Electric Lighting Department of the borough, stated that the amount borrowed on capital account for electric lighting was £42,748. They spent during the half-year £7,620, making a total expenditure to June, 1898, of £53,074, the department having overspent its capital account by £10,725. They had to do the work, whether the money was forthcoming from the Finance Committee or not, and they had to borrow it from their bankers. The total receipts for the half-year amounted to £3,559, against £2,402 for the corresponding half of the previous year, an increase of £1,157. The total expenditure was £1,804, against £1,402, an increase of £402 only. The receipts from the sale of current amounted to £1,138, meter rents £33, and on the fittings account there was a decrease of £14. The total profit for the half-year was £1,755, against £999 for the corresponding half of last year, an increase of £756. He would like the Council to note that the profit on the capital employed was equal to 6·61 per cent., against 5 per cent. for the corresponding half. Incidentally, he might mention that the Gas Department only yielded a profit of 6·11 per cent. In the profit and loss account, he was sorry to say, they had disadvantages to deal with, though only of a temporary character in the matter of interest. The interest for the half-year amounted to £1,127 against £663 for the corresponding half, an increase of £494. The Committee employed during the half-year £13,387 more capital than they had employed in the corresponding half-year, and if they had borrowed that money at 2½ per cent. it would have cost them £177 only. As it was, they paid £494 for it, which was £377 excess of interest paid to the Finance Committee. The net profit available for disposal by the Council was £46, as against a net loss on the corresponding half of last year of £215. But they had now come to a turn of affairs of the Electric Lighting Department, where they had their business continually increasing. Each half-year their business had increased 50 per cent., and this was the fourth year of the undertaking. He believed their business would continue to grow at the same rate, and if so their revenue would be exceedingly good. Extensions of their plant had been going on most satisfactorily, and whatever their demand might be this winter, their plant would be quite equal to it. He did not want anyone to run away with the idea that their first dynamos had been a loss in any way to revenue, through not being able to supply all that was required. Their first machines were designed and delivered to them as being capable of supplying 11,199 8-candle-power lamps. Up to the end of June last, depending solely on those machines, they had wired in Leicester lamps equivalent to 35,000 8-candle-power, and they had supplied lamps at one given time equal to 25,000 8-candle-power with machines delivered to them as equal only to supplying 11,199. They were very satisfied, therefore, with the proved capacity of the machinery they had had, but their business grew so big that it became absolutely necessary to increase their plant. In order to show them the comparatively low figure at which their capital account stood, he had ascertained what those of 10 other corporation electric lighting instalments stood at, these being of a similar size to Leicester. Portsmouth stood at £124 per kilowatt; Salford, £115; St. Pancras, £114; Stafford, £95; Glasgow, £87; Nottingham, £79; Huddersfield, £79; Hull, £71; Bristol, £73; Bradford, £66; as against Leicester, £45. The average of the towns he had mentioned was £90, or double that of Leicester. That was an advantageous position to be in, and it was not because they had got cheap and poor machinery, for theirs was the very best. The fact was, they had not been eager to show profits at the very outset. Their original expectation with regard to this department had been more than realised. They had reduced the price of the current within the last three years to the extent of £1,400 a year. They could easily reduce it still further, if the Council did not mind foregoing profits. Although there was still a deficiency on the revenue account of £1,323, they had got a sum put away in their sinking fund account of £3,923. In conclusion, Alderman Lennard desired to compliment the engineer and his staff, as well as the Committee generally, upon the successful working of this department.

Leigh.—The Board of Trade have approved the Leigh District Council's electric lighting proposals. When the sanction of the Local Government Board to the requisite loan has been received, the works will be proceeded with.

Newark.—Correspondence has passed between the District Council and the Electrical Power Distribution Company, Limited, concerning the introduction of electricity supply into Newark. It has been resolved that the company be given an opportunity of laying information before the Council with regard to the proposal.

Newport.—A Local Government Board inquiry was held on Wednesday last week into an application on the part of the Corporation for sanction to borrow £6,150 for the purpose of electric lighting. The town clerk explained that the total expenditure to date on the electric lighting of the town was £74,665, and the present application would, if granted, bring the total up to £80,815. Of the amount now asked for, £5,000 was for sub-stations and transformers (of which there would be three, viz., at Cardiff Road, at Albion Street, and one at Maindee), and for low tension distributing mains and high tension mains and feeders; and £1,150 was for emergency plant. During the first year of the undertaking there was a gross profit of £224, but the payment in respect of the sinking fund and

interest amounted to £1,634, leaving a net deficiency of £1,410. In the second year there was a gross profit of £864, but the payment of £1,828 to the sinking fund and interest made this into a net deficiency of £912; and the third year the gross profit was £1,716, payment to sinking fund and interest, £2,150, and the net deficiency only £434. There had now been a large increase in the number of lights, which now reached a total of about 20,000. Mr. Robert Hammond gave evidence.

Nottingham.—It is stated that the extension of the electricity station will be proceeded with as quickly as possible, there being urgent need for increased accommodation to meet the growing public demands upon its resources. Plans for the additional buildings are nearly completed, and tenders are shortly likely to be invited.

Northampton.—At the Town Council on Monday it was resolved, on the proposition of the Lighting Committee, to improve the lighting of the main artery of the town from the London and North Western Railway to Abington Square, by using Bray's lamps only. Councillor Purser asked if the committee had considered the comparative cost of electric light. Councillor Martin (chairman of the committee) said that the cost of electric light would be more than the Bray's at present, but he understood that the cost of current would be shortly reduced by the Northampton Electric Light Company. As the town were just now attempting to purchase the electric light company, he did not think it would be very wise for the Corporation to enter into a fresh contract with them for purchasing more of their current. The Northampton Electric Light and Power Company announce that after December 31st the price of current will be reduced from 8d. and 4d. per unit, to 6½d. and 3½d., and for motive power from 3½d. to 3d. per unit.

Paddington.—On Tuesday, at the Vestry meeting, a letter was read from the Metropolitan Electric Supply Company, stating that they had decided from January 1st next to reduce their rate of charge to 4d. per Board of Trade unit for all premises, the maintenance of which was borne by the rates, and expressing a hope that this concession would be appreciated by the Vestry. A member said that the charge to ordinary consumers ought to be reduced, for there was no reason why they should be paying as at present 6d. per Board of Trade unit. Another member said that there had been a reduction in the charges of the company, and he knew that in January the charge would be reduced to 5½d. per unit. It was agreed that the letter be entered on the minutes.

St. Pancras.—At Wednesday's Vestry meeting the Electricity and Public Lighting Committee submitted interim accounts of the working of the electric light station. These accounts, which led to an interesting discussion, indicated that the revenue for half-year which terminated on June 30th last, amounted to £17,408, as compared with £14,320 in the corresponding period of 1897. The expenditure reached £11,556, as against £8,964 in the first half of last year. The net result of the six months' operations was a profit of £1,166, to which was added the profit of £1,717 brought forward from the previous year, making a total profit of £2,883. In connection with the receipts, the Committee pointed out that the introduction of the maximum demand indicator system and other reductions had diminished the income by £800. With regard to the expenditure, the amount under the heading of mains and repairs accounted for £2,822, whilst the coal bill, which had been largely affected by the recent strike, showed an increase of over £500 for the half-year. During the discussion, Mr. Barnes contended that the accounts were not very satisfactory, since they showed a return of only 1 per cent. on the £210,000 invested in the undertaking. Dr. Walter Smith, chairman of the Committee, having expressed the opinion that everybody would be satisfied with the accounts on the completion of the financial year, the report was passed.

Penzance.—The Town Council has resolved not to accept the offer of the Edmundson's Electricity Corporation, Limited, to undertake the supply of electricity for the town.

Poplar.—The District Board of Works has decided by a narrow majority to purchase a piece of land from the trustees of the German Estate for the purpose of an electric station between Violet Road and Glaucus Street, for £3,000. The site is a central position of the Poplar, Bow, and Bromley parishes. Mr. White, a member of the Board, intends to get a special meeting called to reverse the decision come to as he contends that the site is full of water and there are other disadvantages.

Redditch.—The erection of the electric lighting buildings and works is proceeding satisfactorily. In many of the roads mains have been laid, and the scheme may be completed by the end of the year.

Rochdale.—The Board of Guardians Committee has received 27 tenders for the workhouse electric lighting installation. They are under consideration.

Rugby.—On 29th ult. the Urban District Council decided to apply for a provisional order for electric lighting, and referred the matter to the General Purposes Committee.

Shoreditch.—Owing to the rapid increase in the demand for electric current, and on the advice of the chief engineer, the Lighting Committee advised, and the Vestry agreed, that a 100-kilowatt transformer, complete with the necessary switch gear, be ordered from the Electric Construction Company at £881, on the terms and conditions of their tender, and that tenders be invited for two smaller transformers of 66 kilowatt capacity each.

St. Helens.—The subway is to be lighted by electricity, and the Corporation has given the contract for the work to Mr. Chas. Rettie. There will be 60 lamps placed 30 yards apart.

Stretford.—At Tuesday's Council meeting Mr. Johnston moved the adoption of the minutes of the General Purposes Committee under date September 27th, which provided for the appointment of an electrician to advise the Council on the electric light and haulage scheme, and also for the appointment of a sub-Committee to select a suitable electrician and define the terms of reference. The minutes were approved by 8 votes to 7.

Swansea.—The Tramways and Electric Lighting Committee on Monday resolved to advise the Corporation to defer the dust destructor proposal for the present on account of the difficulty in procuring a suitable site; also to ask Mr. Manville to prepare amended plans and estimates of an electric lighting station to be erected on the Corporation property on the Strand. To-morrow, Saturday, Major Hutchinson will hold an inquiry on behalf of the Board of Trade, to settle the difference between the Tramways Company and the Corporation.

Tunbridge Wells.—The Electric Light Committee of the Town Council have resolved upon an increase of arc lamps in various parts of the borough.

Vyrnwy.—The Water Committee of the Corporation have recommended to the Council that the tender of Messrs. Christy Bros., of Chelmsford, to carry out the necessary work for electric lighting at Lake Vyrnwy, in accordance with specification, for the sum of £676, be accepted.

Walthamstow.—On Wednesday last week a Local Government Board inquiry was held into an application by the District Council for sanction to borrow £41,690 for electric lighting. The inspector said he thought it was probable that another inquiry would have to be held, as notices calling attention to the inquiry had not been posted on the church and chapel doors in the district. Mr. Ebenezer Clarke opposed the application on the ground that Walthamstow already had heavy outstanding liabilities, and that there was no demand for the electric light. Mr. Enright, the electrical engineer, explained the proposed scheme. The inspector said he saw nothing in the scheme to object to, except the proposal to wire private houses at a cost of £5,000. He could not recommend this to the Local Government Board, as a fresh tenant might decline the electric light, and the wires would have to be taken out at the expense of the ratepayers.

Waterloo.—A Local Government Board inquiry into the application of the Urban District Council for power to borrow £750 for public lighting purposes was held at the Town Hall on 28th ult. Mr. Cleaver, solicitor, explained that the application was divided into two heads. The first was for £550 for the lighting of Great George's Road and South Road. In these roads gas is to make way for electricity. The Liverpool and District Lighting Company, Limited, had obtained an order in 1896 for supplying the district with power of lighting. They had erected a generation station, and the works were now in operation. The lamps to be used were similar to those used in Liverpool. Half the cost of the service loss was to be defrayed by the lighting company, and half by the Council. The Electric Lighting Company would lay the mains, the Council provide the standards and carriers, and the lighting company would fix and maintain them. The remaining £200 was in respect of an electric light installation in the Town Hall.

West Bromwich.—The Electric Lighting Committee will ask the Town Council to empower them to employ an expert to advise them as to the best means of carrying out the lighting order, and to authorise them to obtain any requisite information for that purpose.

West Ham.—The Town Council had a discussion some days ago as to whether they should start the supply of current on September 29th with only one set of plant in position. It was resolved to wait until the second set, which has been tested and is nearly ready, has been placed in position, so as not to run risk of breakdown. The electrical engineer, in a report recently submitted to the Highways and Parks Committee, says that in his original report two years ago he made provision for the equivalent of 6,500 8-C.P. lamps for the Romford Road and Woodgrange Road district, but applications have already been received for that district equal to 6,527 lamps. He drew the attention of the Council to this, as it takes some time to get the permission of the Local Government Board to raise loans, and it is a difficult thing to get electrical machinery delivered in a hurry. He also draws attention to the question of electric tramways, and recommends a suitable spot for a tramway sub-station. If lighting mains are laid to Upton Lane he says that tramway feeders should be put down at the same time. He says that actual work on electric light extensions ought to commence early in March, 1899.

Whitechapel.—The Board of Works has granted the City of London Electric Lighting Company permission to lay electric mains from Cooper's Row to Messrs. R. H. Thompson & Co.'s premises at 33, Trinity Square.

Whitehaven.—The Whitehaven Congregational Church will shortly be lighted electrically if the offer of a would-be donor is accepted. Messrs. Ramsay Bros. will do the work.

Wigan.—On Wednesday the Council decided that the Electric Lighting Committee visit towns where combined systems of electric lighting and electric traction have been adopted, and report.

Wigton.—Now that the electric light is being installed in the city of Carlisle, 11½ miles distant, a few members of the Wigton Urban District Council are seriously considering the advisability of introducing electric lighting into the town.

Willesden.—At the District Council on September 27th, the solicitor, Mr. W. G. Greig, reported that the provisional order received the Royal assent on September 12th. The matter was referred to the Works Committee. It was reported by the Works Committee that they had appointed a sub-committee to consider the applications for the post of electrical engineer to the Council, and to select six names from the list from which the engineer is to be chosen.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Tramways Committee has had under consideration a report from the sub-committee on the questions of extensions, method of traction, &c. Mr. Dyack, burgh surveyor, submitted a report to the effect that the line from Kittybrewster to Woodside was beyond repair, it being completely worn out. The committee, in these circumstances, agreed to proceed immediately with the doubling of that part of the system, and to lay lines which would be suitable for electric traction when it was introduced. The lines between Market Street and Kittybrewster at present in use are also to be replaced by others suitable for electric traction. A provisional order is to be applied for with a view to carrying out this improvement, which is estimated to cost about £18,000.

Barrow.—The General Purposes Committee last week considered the report of a sub-Committee recommending the municipal purchase of the tramways for about £22,000. The matter was adjourned for a fortnight. The company is stated to have received an offer from a private firm.

Belfast.—The Corporation on Saturday did not pass the resolution recommended by the Electric Committee as printed in our last issue. The Council will discuss the matter in committee.

Bradford.—Hot bearings were responsible for the electric tramway plant at the station being brought to a standstill last Sunday afternoon. For several hours the cars were not running. When the new plant now on order from Messrs. Siemens Bros. is in position, the works will be quite prepared for such an emergency if it occurs again.

Cardiff.—On Monday afternoon a Council deputation went to Kidderminster, from whence they will proceed to visit several of the larger towns in the North of England, where electric tramways are working. The deputation will report to the committee who have charge of the proposed electric tramways upon the best systems now in use.

Glasgow.—The *Glasgow Evening Times* has been interviewing ex-Bailie Paton with reference to the Springburn electric tramway section. Writing on 27th ult., our contemporary said that the engines would be working in a fortnight, and that thereafter there would be trial runs for several nights to get the car drivers used to the new system. From Mitchell Street to Springburn the track has been prepared, and the posts and wires erected.

Hawaii.—The directors of the Hawaiian Tramways Company, Limited, in their latest report, say: "The change of the motive power to electricity has become of urgent importance, and the directors are taking steps towards a gradual installation."

St. Helens.—The *London Gazette* contains notice to the effect that the Corporation is applying to the Board of Trade for approval to the demise by lease of the tramways undertaking to the new St. Helens and District Tramways Company, Limited, for a term of 21 years, at a rental of £2,400 in the first half-year, rising by successive stages to £3,500 during the last four years of the term. The lessors are to relay and repave certain portions of the tramways, and are to provide the necessary equipment for the use of electricity as the motive power on certain specified terms, and the lessees are to provide the necessary rolling stock.

Isle of Thanet.—It is stated that the plans, &c., for this electric tramway scheme are being prepared as speedily as possible, and it is anticipated that a start may be made with the preparation of the track in November. The line will doubtless be opened by next season.

Keighley.—At the annual meeting of the Keighley Tramways Company on September 29th, there was some talk about electric traction. The chairman of the company (Mr. Herbert Hoggos) said there was no doubt if the Corporation put down an installation, the company would go in for electric cars. Electricity was, without doubt, cheaper than horses for traction. On September 27th the Keighley Corporation passed the following resolution:—"That application be made to the Board of Trade on or before December 21st for a provisional order, to be confirmed by Parliament, to empower the Mayor, aldermen, and burgesses of the borough of Keighley to supply electricity for public and private purposes within the borough."

Leicester.—A special committee of the Leicester Corporation have entered into a provisional agreement to purchase the tramway undertaking, hitherto in the hands of a company. The price to be paid by the Corporation is £129,500, the Corporation also agreeing to take over the liability to pay off the company's debentures, amounting to £24,000.

Liverpool.—At a recent meeting of the Watch Committee, a report was read from the assistant head constable as to the electric tramway wires interfering with the running of vertical fire escapes, and it was resolved to obtain specifications and estimates for two horizontal fire escapes.

The Metropolitan Railways and Electric Traction.—Mr. J. S. Forbes, addressing the shareholders of the Metropolitan District Railway Company on 29th ult., said that in connection with the proposed new extension (Whitechapel and Bow line) the question again came to the front as to the use of electrical traction. They had no doubt seen what had taken place in the last few months. The extraordinary fine weather and the coal strike in Wales had punished their traffic. The use of Welsh coals had choked their tunnels. The adoption of electrical traction would get rid of those disadvantages. He thought the salvation of the District Company, and the Metropolitan Company, too, depended to a certain extent on the substitution of electricity for steam. They had powers to adopt the electrical system, and one of the objects of the resolutions before them was to put that into effect, which would involve £500,000 in the case of the District Railway; but the directors did not desire to ask the shareholders to incur that cost until they had before them the report of such eminent electrical authorities as Sir Wolfe Barry and Mr. W. H. Preece, the electrician of the Post Office.

A New Closed Conduit System.—A public trial of Mr. Christopher Anderson's closed conduit tramway system was made in Harehills Road on Monday afternoon, in the presence of the Corporation, tramways officials, and some members of the Tramways Committee. Mr. Anderson had for the purpose of the trial utilised by the Corporation's permission about half a mile of track. The *Leeds Mercury* describes the system as follows:—"He has placed between the rails, iron boxes, sunk to the level of the road, and some 18 feet apart. These are 3 feet long by 1 foot broad, and they enclose the mechanism which supplies to the tramcar its motive power. As the car passes over each of these little chambers a rod rises 4 inches above the level, and coming in contact with what may be termed the brush, transmits to the motor under the vehicle a supply of electricity. This done, the rod drops into the chamber, and the one immediately ahead of it rises automatically, and renders the same service, after which it also descends. This operation is continued along the whole of the track. It is only when the rod is elevated that it is electrically alive; the lowering of it breaks the current, and as it falls before the car has quite passed over it, there is no danger of any one receiving a shock, though the top of it is level with the surface. It may be asked, How is the car started? When it is about to leave the shed, the rod in the first box has to be raised; the rest depends upon the automatic action described. For his experiments Mr. Anderson has obtained the electrical current from the Corporation's station."

Newcastle.—A correspondent is informed upon reliable authority that the new Tramways Committee of the Newcastle Corporation having interviewed tramway experts (cable and electric) *re* the various technicalities in the working of the two systems, will draw up a report of the interview, which will shortly be presented to a full meeting of the Council.

Oldham.—The proposal of the Corporation to run their own trams is going forward. As already stated, the Oldham authorities wrote to the out-townships—Royton, Crompton, and Lees—asking to be allowed to run their trams through the districts, and the replies from the two last-named districts are favourable. Oldham will now include the districts of Crompton and Lees in their proposed Bill to be laid before Parliament. The chairman of the Surveyors' Committee and the borough surveyor went over the proposed route with the members of the Lees District Council, after which the latter body passed a resolution, and gives its approval for Oldham to apply to Parliament for powers to run electric or other trams within the urban district of Lees. Three years will be given to carry out the scheme.

The Royton District Council on Monday, after conferring with representatives of the Crompton District Council, decided that it would be most advisable for the Royton District Council to acquire or own the tramway lines in their district, and to lease the running powers for a term of years upon such terms or at such a rental as would enable them to be recouped at the expiration of such terms for the capital expended, together with the annual cost of repairing and maintaining the lines. Subject to such conditions to be hereafter agreed upon, the Council authorise the Corporation of Oldham to provide in the proposed Tramway Bill for acquiring the requisite running powers in regard to the district of Royton.

The work of constructing the line for the electric tramway system from Ashton to the steam tram terminus at Hathersham, Oldham, is proceeding apace. The rails have already been laid down, and the connections of the different lines are being completed. The posts for the overhead wire have also been erected on a great portion of the route. It is not known when the cars will actually be run.

Salford.—The Highway Committee make the following recommendation in regard to the appointment of adviser on the proposed electric tramways for the borough:—"That Mr. Charles Hopkinson be appointed to advise this Committee upon the same terms as those upon which the late Dr. Hopkinson was appointed."

Southampton.—At the last meeting of the Town Council it was reported that the receipts from the tramways showed a considerable advance over corresponding weeks last year, when they were the property of a company. The Tramways Committee had received a report from Mr. Kincaid upon the subject of adapting the permanent way for electric traction, and it had been decided to convene a special meeting to consider it.

Southend.—The Town Council will hold a special meeting on October 26th to decide whether to apply for a light railway order for laying down a system of electric trams for the principal streets of the borough, and including Prittlewell, Leigh, Southchurch, Westcliff, &c. The Council already has an electric lighting order, and it is suggested to put down a combined lighting and tram plant. The tram scheme would include 10 miles of system, and the total cost, including buildings, would be £80,000.

TELEGRAPH AND TELEPHONE NOTES

Pacific Cable.—A well considered article in this month's *Nineteenth Century*, by Mr. Benjamin Taylor, refers to the Nicaragua canal and the Pacific cable as important factors in "the coming struggle in the Pacific," and we think we cannot do better than make an extract of that part which refers to electrical communication with the East. We have repeatedly expressed the views Mr. Taylor expounds as to the insecurity of the existing telegraph lines, and have pointed out how easy it would be for an European power to destroy all communication *via* the Cape of Good Hope and through the Mediterranean and the Red Sea. These lines would probably be safe enough if our quarrel was with the United States; in fact, as the routes are far removed from the probable scene of action, one may consider them perfectly safe for ordinary purposes. The case, however, is far different if an European power is our antagonist; without a Pacific cable we shall have, at the best, an insecure, and for that reason, dangerous means of communication. The danger of having on our hands at one time, a war with an European power and with the United States, is so slight that a Canadian Pacific cable would be practically a secure route to the East when the cables of the Cape, Mediterranean, and Red Sea are interrupted by an European adversary. Mr. Taylor's article says:—"In considering the future of the Pacific, the subject of cable communication cannot be ignored. At present we are linked telegraphically with our Eastern Empire by four lines of wire: (1) *viâ* Lisbon, Egypt, and the Red Sea; (2) *viâ* France, Italy, Egypt, and the Red Sea; (3) *viâ* Germany, Turkey, Russia, and the Pacific Coast; (4) *viâ* Lisbon, West Africa, the Cape, and the Indian Ocean. The recommendation of the Selborne Conference, in 1896, in favour of an all-British cable to the Pacific has not been acted upon, mainly, perhaps, owing to one reason that has never been mentioned in public discussions of the matter, which is that the overland telegraphs in Canada, which must form the connecting links between the two ocean cables, are 'controlled' by a powerful United States telegraph combination. So long as that control exists, a telegraphic connection between West and East, *viâ* North America, would be all-British only in name. If cables are to be no longer regarded as immune from attacks in time of war, we might have very serious complications in American rights over Canadian landlines. Are they, in present circumstances, any more dependable for Imperial purposes than is the Russo-Siberian line of communication, on which Lord Wolseley has said that it is 'suicidal' for us to depend? It may, however, be argued that the very fact of this American impact upon the all-British line of Imperial inter-communication emphasises the necessity for an Anglo-American bond of what Mr. Chamberlain calls 'permanent amity.' The four existing lines of telegraph with the East all pass through the dominions of several foreign governments. The enmity of one of these governments would sever two or more of these lines. The cables in the Red Sea would be at the mercy of any belligerent. In fact, in the event of a war with a European maritime power, we would be absolutely dependent on the very precarious link round the Cape, which might be broken at many different points. Russia makes no secret of the fact that, in the event of a war with us, her first task would be to cut off all our wire communications with India and Australia; and it is known that she has bad ready cable-cutting ships to despatch on short notice. There seems little room to doubt that a cable laid in the great depths of the open Pacific would be much less open to attack than any existing, or perhaps any possible alternative line. But a little reflection will show that, desirable as is this all-British bond of wire by way of North America and the Pacific, its value will depend on the preservation of 'permanent amity' with the United States. We cannot yet count on that, and therefore we cannot afford to reject the plan for a complete system of entirely British cables connecting all our naval stations with London, India, and Australia. It is a curious thought that in seeking to reach the Orient by a canal across Nicaragua, and by a cable across the Pacific, we are just carrying out the design of the old Spaniards to reach the East by the West. We have successfully followed the Portuguese Vasco de Gama round the Cape of Good Hope, to Mombassa and India. And now we are following upon the Westward track of Columbus when he went in search of Zipandu; and of Alvaro de Mendañ when, setting sail from Callao, he plunged into the wide Pacific in search of the Islands of Solomon."

Telegraphic Communication with Klondyke.—A Reuter despatch, dated Ottawa, October 3rd, says that the Hon. James Roche, M.P., representing British capitalists, has acquired the charter granted by the Dominion Parliament last session for the erection of a telegraph line to Dawson City, and that he has now arranged with the Government for the construction of the line, which will be commenced forthwith.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies—		
St. Lucia-St. Vincent	Sept. 24th, 1898	...
St. Vincent-Grenada	Sept. 24th, 1898	...
Santiago Caimanera	Sept. 27th, 1898	Sept. 29th, 1898.
Amazon Company's cable—		
Cable beyond Gurupa	June 8th, 1898	...
Bolama-Bissao	June 31st, 1898	...
Perim-Assab	Sept. 13th, 1898	...
Seychelles-Maurice	Sept. 18th, 1898	Oct. 1st, 1898.
Landlines.		
Majunga-Tananarive	Sept. 19th, 1898	Sept. 20th, 1898.
" "	Oct. 3rd, 1898	Oct. 4th, 1898.
Saigon-Bangkok	Sept. 27th, 1898	Oct. 4th, 1898.

West Indian Telegraphs.—A Barbados account of the terrible hurricane which recently did such awful devastation in the West Indies, says that on September 14th every branch of business was suspended in the city, all the stores and commercial offices being closed. "The landlines of the W. I. and P. Telegraph Company have been demolished, and cable communication with the other islands was interrupted."

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 27th. The municipal authorities of Ghent are inviting tenders until October 27th for an installation of electric lighting in the new Flemish theatre in that town. Tenders to L'Hotel de Ville, Ghent, Belgium, from whence particulars may be obtained.

General Post Office.—October 25th. The G.P.O. is inviting tenders (*a*) for the supply of red fir telegraph poles, to be delivered in London, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10 lbs. or 12 lbs. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1898-9. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E. Stuart, controller of stores.

Ghent.—October 29th. The Ghent Municipal Council is inviting tenders for the installation of the electric light at a new theatre. The work, says *Daily Tenders and Contracts*, has to be completed by June 1st, 1899 (a fine being imposed for every additional day to completion), and maintained for 12 months. Labour clause. The contract includes the supply and delivery of 1,337 incandescent lamps, 20 arc lamps, &c. All expenses for registering, stamps, notices, &c., which are estimated to cost 130 francs, to be paid by the contractor. A deposit of 8,000 francs is required, on which 2 per cent. will be paid after 60 days. Specifications seen with, and plans obtained, on payment of 40 francs, from M. Le Sécrétaire Communal (A. De Bruycker), Gand, or at the office of the paper mentioned above. Tenders, on stamped paper, registered, addressed as directed, with a certificate of deposit, to be posted by October 27th. The tenders will be opened at 11 a.m. on October 29th.

Great Western Railway.—October 24th. The directors are inviting tenders for the supply of various stores for a year commencing December 1st, 1899. Among the items are telegraph instruments, apparatus, ironwork and tools, and drysalteries; copper wire, G P. wire, &c.; electric light carbons, and incandescent lamps; telegraph poles, &c., &c. Specifications, &c., from the offices of the Stores Superintendent, Swindon. For further particulars see our "Official Notices" this week.

Italy.—October 11th. The Italian naval authorities at Spezia are inviting tenders until the 11th inst. for the supply of the interrupters, rheostats, commutators, and other electrical supplies required during the financial year, 1898-99. Tenders to be sent to La Direz. delle Torpedini e del materiale elettrico 1° dipartimento maritt. Spezia, Italy.

Kingston-upon-Hull.—October 27th. The Electric Lighting Committee invites tenders for the supply and erection of certain plant in connection with the electricity works, including high and low tension mains, casings, trench work, &c.; switchboard, continuous current rotary transformers, motor-generator, &c.; centrifugal pump, condenser (ejector type), steam pipes, &c. Electrical engineer, Mr. A. S. Barnard. See our "Official Notices" September 23rd for particulars.

Leigh.—October 14th. The Electricity Committee want tenders for the supply and erection of steam dynamos, switchboard, accumulators, mains, meters, overhead crane, water softener, &c., for the electricity scheme. Particulars from the engineer, Mr. John Foster, Leigh, Lancs. See our "Official Notices" September 23rd.

New South Wales.—October 17th. The New South Wales Government is, according to *Daily Tenders and Contracts*, inviting tenders for the supply for the Department of Posts and Telegraphs of a steam engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Further particulars, &c., obtained from, and tenders to, the Secretary, General Post Office, Sydney, N.S.W.

Oldham.—October 11th. The Corporation are offering for purchase by tender of 67 E.P.S. and 67 Crompton-Howell storage cells, each of 500 ampere-hours capacity. The latter class of cells have been partly re-plated with chloride positives. May be seen at the supply station, Gas Street. Tenders to the Superintendent.

Southampton.—November 16th. The Committee of Visitors of the County Lunatic Asylum, Knowle, near Fareham, are inviting tenders for the supply of two engines and dynamos equal to an output of 24,000 watts each, together with all necessary washing machinery, lathe, drill, motors, lamp installations, &c., required in connection with the centralisation and increase of the light, heat, and power generating plant. See our "Official Notices" this week *re* specifications, plans, &c.

South Shields.—October 19th. The Corporation wants tenders for the supply and erection of vertical triple expansion engine, 800 I.H.P. or 1,000 I.H.P., with surface condenser; and an ironclad or inductor type alternator, 400 or 500 kw. Specifications, &c., from the borough electrical engineer's office, West Holborn. See our "Official Notices" this week.

Warsaw.—The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Warsaw stating that the Municipal Council of that city invite tenders for the exploitation of the tramways of Warsaw under municipal control. Horse traction, says the *Times*, is at present in use, but it is intended to introduce electricity as soon as possible. Information as to the conditions can be obtained from the Magistrat de la Ville de Varsovie, Varsovie, Russie.

CLOSED.

Ilford.—The Urban District Council has accepted the tender of the Consolidated Telephone Company to provide a telephone service to the new hospital at Shadwell, and also to furnish a system for inside telephone communication.

Leeds.—The following tenders have, says the *Contract Journal*, been accepted subject to the approval of the City Council for the supply of (*a*) poles; (*b*) trolley wire and attachments, in connection with the extension of their electric tramway systems: J. Russell & Son, Leeds, (*a*) £5,058; British Thomson-Houston Company, Limited, London (*b*) £4,248.

Paisley.—The Parish Council has accepted the estimate of Messrs. Jas. Kilpatrick & Son for electric wiring, &c., for its new offices in Paisley.

NOTES.

Side Lights on Cable Routes.—In the *Melbourne Argus* of August 26th we notice a long article (No. 1) under the heading of "The Proposed Pacific Cable." We do not intend to criticise this, as it is simply a *rechauffé* of the objections and misleading statements which those who are interested in opposing the laying of a cable across the Pacific take every opportunity of publishing for the consumption of the colonial public, who have not had the opportunity of acquiring a proper insight into the matter. This knowledge might have been in their hands had the proceedings of the Commission of Inquiry, held in the Colonial Office at Downing Street at the end of 1896, been presented to the House of Commons. The supposed analysis of the Pacific scheme now being published in Australia is, as has previously been the case, utterly misleading, and evidently springs from a biased source.

Durham College of Science.—On 28th ult. Prof. H. Stroud delivered a lecture in the hall of the Durham College of Science, in the course of which he dwelt at considerable length on the subject of Lord Armstrong's electrical discharge experiments at Craigside.

Earth Returns on Tramways.—*Apropos* of Prof. Rücker's presidential address before the International Conference on Terrestrial Magnetism at Bristol, the following extract from a recent issue of a St. Louis paper is of interest:—"What may prove the most wonderful electrical discovery of recent years has been made by operatives of the Bell Telephone Company. Electricity for light and power may be had free as air. Anybody with a strand of copper wire may avail himself of the mighty force that propels the street cars of St. Louis." One would suppose, from the above, that the Bell Telephone Company's operatives had solved the problem of converting sunlight into electrical energy. They have not, however, tapped a new source of electricity; they have merely tapped the wandering earth currents of the St. Louis street car system. The Bell Telephone Company, of St. Louis, have recently met with difficulties in working their system, and their manager, Mr. G. F. Durant, has discovered that the ground under St. Louis is saturated with earth currents sufficient in power to produce light when a lamp is put into circuit between two fairly distant points. Mr. Durant looks forward to the happy time when the citizens of St. Louis will avail themselves of this new supply for lighting their homes, and he even talks of utilising these wandering currents for power purposes by means of storage cells. Probably before his plans are matured the Street Car Company will have come to the conclusion that it does not pay to provide the citizens of St. Louis with light and power free of charge, or to electrolyse the underground gas and water mains upon such an extensive scale, and will have amended their ways. But the discovery by Mr. Durant of the energy of some of these earth currents, taken in conjunction with Prof. Rücker's facts as to the distances to which they may travel, open up a new vista. The back garden of the thrifty citizen of, say, Blackpool, Bradford, or Dover, may cease to be an unremunerative patch of ground, capable only of growing weedy crops of vegetables with an infinitude of personal care and attention. The said citizen will no longer spend his summer evenings and surplus cash in horticultural experiments, but will lay himself out *to tap earth currents*. With a few oven shelves buried in his back garden, and all his available warming pans in the front, and electrical contact between the two, his patch of ground *may (!)* supply heat and light to his household, and become in a small degree a veritable Eldorado. We do not, however, guarantee success to these experiments in this country, and the most promising field of operation would certainly appear to be upon the other side of the Atlantic.

Presentation to Mr. Frank King.—An interesting ceremony took place at the works of the Electrical Power Storage Company, Limited, Millwall, on the 29th ult., in the presence of some 300 of the staff and employés of the company, on the occasion of a presentation to Mr. Frank King on his retirement from the post of manager of the company. The presentation, which represented the joint contributions of the directors, staff, and workmen, consisted of an illuminated address, together with a silver centrepiece for the dinner table. Mr. John Irving Courtenay, chairman of the company, in making the presentation, alluded to the enormous progress the storage battery industry had made since Mr. King became connected with the company in 1886, and in which the Electrical Power Storage Company had so largely participated. Mr. Courtenay pointed out how much the company was indebted to Mr. King's efforts for the premier position it now occupied. While expressing their unanimous regret that the state of Mr. King's health had necessitated his resigning the post of manager, he had much pleasure in stating that the company would continue to have the benefit of Mr. King's services as a member of the board of directors. Mr. King briefly replied, expressed his deep sense of the compliment that had been paid him, and his sincere appreciation of the kindly feelings that had always been manifested by all those with whom he had worked for so many years. Mr. Courtenay was supported by Mr. Fred. Green (a director), Mr. H. W. Butler (Mr. King's successor), Mr. Walter Clark (the works' superintendent), and Mr. W. C. Burford (the accountant).

An American Gas Power Station.—The *American Engineer* describes a gas power station using Indiana natural gas. In Ohio and Indiana natural gas can be bought for 3½d. per 1,000 cubic feet. The installation in question is at Lafayette, and the cost of fuel is only 22 per cent. what it was before gas power was installed. There are 3 units, each consisting of a 125 H.P. engine belted to a 60 kw. dynamo. Two are so far at work. The dynamos are two-phase Westinghouse of 7,200 amperes per minute, 2,000 volts, and 900 revolutions per minute. They furnish current for 40 enclosed arc and 1,000 incandescents, as well as for a 50 H.P. rotary transformer. The gas engines are Westinghouse type, guaranteed to do 125 H.P. with not over 14 cubic feet of gas containing not fewer heat units than Pittsburg natural gas. Their cylinders are 13 inches diameter × 14 inches stroke; their speed is 265. They are fitted with a gasoline tank and carburator in case of the natural supply failing, as it may do in cold weather. For this gasoline the cylinders are provided with a bonnet, which acts to increase the clearance, and so reduce compression, and prevent otherwise premature explosion. Cooling water is heated to 180° and cooled by evaporation in air currents. In this way the water is used over and over again, and there is no danger of incrustation as with a constant supply of fresh and, perhaps, hard scale-forming water. Four to five gallons of water are used by each engine per hour. To each engine are provided four tanks of 7 cubic feet capacity to contain air at 160 lbs. pressure. These are filled by a small pump on the engine, and in starting, this air is used in one of the three cylinders of each engine. The air pressure is restored by running the air pump a short time. Thus one cylinder acts as an air motor, while the other two are ready to work with gas. Three or four revolutions are enough to start with when the middle cylinder is cut off from the air and fed with gas. Regulation is by an adjusted charge, which is looked on as better for electric light work than the more economical method of cutting out explosions. About a twelfth of a penny per H.P.-hour will be found possible with gas at 3½d. per 1,000 feet. Indiana natural gas is very rich in hydro-carbons, yielding 1,050 heat units per cubic foot. It may be diluted with 12 to 14 times its volume of air. The cranks are at 120°. The throttling of the inlet, by which regulation is effected, has the effect of reducing the compression. The mixture is constant, so that not only is less gas admitted on a throttling stroke, but less air. Hence the reduced pressure of compression after such a stroke.

A Convenient Rule for the Calculation of Three-phase Circuits.—One of the most popular circuits in multiphase transmission is the three-phase, three-wire system. The calculation of the proper sizes of wire for a power transmission upon this system has frequently bothered devotees of direct current. In attempting its solution, says the *American Electrician*, they very shortly are tangled up with the square root of three, which has unaccountably incorporated itself into their calculations, and they are also likely to calculate the three drops, one on each wire, and are then in a quandary as to whether these should be added, averaged, or the third neglected. A simple and satisfactory rule is the following:—The ratio of the amounts of copper used for equal power, drop, and voltage is 100 for the single-phase and 75 for the three-phase system. The single-phase system, as is well known, is calculated by ordinary direct current rules, and uses two wires. The three-phase system uses three wires. It then follows that, if we calculate the proper size of wire by ordinary direct current rules, and then divide the circular millage of that wire by 2, we shall have the proper size of wire for a three-phase circuit, because 75 per cent. of the volume of two wires of a given size is equal to the volume of three wires of half that size, lengths being equal.

The Italian Electro-Technical Association.—The second annual meeting of the Associazione Elettrotecnica Italiana was held in Turin from the 25th to the 28th ult, when papers were read by Ing. Lorenzo Ferraris on "Electricity at the Turin Exposition," and by Ing. E. Cairo and Ing. P. Lanino on "The Application of Electric Traction on Railways."

Personal.—Mr. Reginald J. Wallis-Jones informs us that he has entered into partnership with Mr. M. C. Dent for the purpose of carrying on business as consulting electrical engineers at 36, Great George Street, S.W. Mr. Wallis-Jones has had about 17 years' varied experience in electrical work, and will report on electrical schemes of every description. Personal supervision will be given to this work, and also to the testing of electrical machinery and plant. We understand that Mr. Wallis-Jones has been retained as engineer by the Electric Welding Company, with which he has been associated.

Mr. J. H. Woodward has resigned the position that he held as chief of the staff of Thomas Parker, Limited, Wolverhampton.

Dr. J. Erskine Murray, the assistant Professor of Physics in the Heriot-Watt College, has been appointed electrician to the Wireless Telegraph and Signal Company.

Mr. George A. Zeden has resigned his appointment on the technical staff of the Brush Electrical Engineering Company, in order to take up the position of managing engineer to Mr. W. C. C. Hawtayne, consulting engineer, of 20, Bucklersbury, E.C. During his 10 years' service with the Brush Company, Mr. Zeden has spent six years in their estimating department in London, and before leaving on Friday last, he was presented by some of his immediate friends and colleagues at the head office with a handsomely fitted travelling bag, as a mark of their warm personal regard for him.

Lord Salisbury is stated to have intimated to the Marquess of Tweeddale that Her Majesty has been pleased to confer upon him the Ribbon of the Thistle, vacant by the death of the Earl of Mansfield. The *Daily Telegraph*, commenting upon the matter, says:—"Since his Lordship quitted political life in 1878 he has been deeply and actively engaged in the management of telegraph companies, and he succeeded the late Sir John Pender in the chairmanship of those which are popularly known as the 'Eastern' group. As Lord William Hay he was one of the first directors of the cable from Malta to Alexandria, which was the nucleus of the vast and complicated system that connects London with the Far East to-day. Indeed, he is the only surviving director of all the original Pender companies. Lord Tweeddale has also been chairman of the North British Railway Company during the past 12 years. He is a man of strong business habits and simple tastes, which were acquired during his Anglo-Indian experience of 15 years—a period covering the whole of the Indian Mutiny, in the course of the suppression of which he earned at Simla signal credit." The *Telegraph* assumes that this honour is in recognition of the admirable manner in which, for five years, Lord Tweeddale represented the Queen as Lord High Commissioner to the General Assembly of the Church of Scotland.

Mr. Val. A. Fynn has resigned the position of chief electrician to Messrs. Easton, Anderson & Goolden.

Gas and Electricity.—A number of members of the Incorporated Institution of Gas Engineers, while holding their conference at Manchester, went through the Bradford and Gaythorn Gas Works, under the guidance of the Gas Committee of the Corporation. At the invitation of the Lord Mayor, who is chairman of the Gas Committee, the visitors afterwards had luncheon at the Town Hall. The Lord Mayor, in welcoming the visitors, said it seemed a very extraordinary thing that not only in Manchester, but in other large towns where electricity had become a great factor, an increased production of gas had kept pace with the demand for electricity. Manchester, five years ago, started an electric light installation, which at the time was thought to be a large one, as it consisted of 20,000 16 C.P. lamps. It was thought that this would last for a decade at least, but it did not last for 12 months. Since then there had been an enormous number of electric lamps brought into use; but notwithstanding that, there had been a considerable increase in the demand for gas.

The Institution of Junior Engineers.—The annual general meeting will be held on Friday, October 14th, at 8 p.m., at the Westminster Palace Hotel, for the reception of the Council's report, for the election of officers for the eighteenth session, &c.

Lightning Arresters.—In connection with Mr. Preece's remarks on lightning arresters in the course of the B.A. motor discussion, the following letter appearing in the *Western Electrician* from the pen of Mr. W. R. Garton will be of interest:—

Allow me to say a few words relative to the installation of lightning arresters. I have had considerable experience with this class of work, and I have noticed several improper methods, which may be avoided without difficulty.

For one thing, it is always well to follow the directions given by the manufacturer. All electric railway and light companies employ men classed as linemen or electricians, who are entrusted with the installation of the various instruments or devices which are purchased for their plants. It is often the case that these men trust to their own judgment rather than to the judgment of the manufacturer, and instal the apparatus in accordance with their own ideas. This is a mistake. It is not that these men are not well versed in their business; they are often in possession of valuable information gleaned from their own practical experience; but it is always better to carry out the instructions of the manufacturer, and to let him shoulder the blame if the operation of machines or instruments is not satisfactory. I have found many such cases to explain the reason for the failure of lightning arresters to protect plants, transformers, &c.

Lightning arrester lead wires should never be curled or twisted around span wires, or tied into knots to take up the slack. If the wire is too long, it should be cut to the proper lengths, and made as straight as possible.

To test lightning arrester grounds, especially on railway circuits, a bank of five lamps should be carried, and if, when the terminals of the lamp circuit are connected with the line and the ground terminals of the lightning arresters, the lamps come to candle-power, the ground may be considered as satisfactory. Otherwise it should be improved.

As a matter of mechanical protection, gas pipes have been used to cover the ground wire, and in hundreds of instances have rendered the lightning arrester useless, as the iron pipe around the wire acts as a choke to the discharge. Wherever ground wires are run to the ground through pipes, they should be connected to the pipe through which they run. This applies to any wire in a lightning arrester circuit. Where installations have been made in this way I have often advised removing the installation from the wire at the top of the pipe and driving a wooden wedge into the pipe to force the wire against the pipe to keep it in that position. The ground wire should never be alive, and therefore there is no danger from having the wire connected with the pipe. Lightning arresters which were unsatisfactory with the wire run through the pipe have proven very satisfactory after making the change suggested here.

Electrolytic Action on the Brooklyn Bridge.—A recent accident on the bridge, which resulted in the buckling of several of the girders, has been the subject of numerous scare heads in the American daily papers, and mysterious illusions to the deadly current which is supposed to be continually gnawing at the foundations of the bridge. There is, without question, says the *American Electrician*, a considerable current flow in the cables of the bridge. This is evidenced in numerous ways. A compass needle placed over the cable will deflect at right angles thereto, and frequently flashing arcs are noticed between the traction cables and the pulleys on the traction cables and the pulleys at the termini. The current has been thought to have its origin at the foot of Fulton Street, where there is heavy traffic and frequently congestion of traffic. From this point the current that is fed into the ground must reach the Kent Avenue power house by a somewhat circuitous route around Wallabout Bay. A portion is supposed to enter the bridge at the Brooklyn anchorage and traverses the cables, for the most part, across the river to the New York end. It thence proceeds up the East River shore and across the river above Wallabout Bay to the station. Experiments with the compass needle, however, show that the current is frequently travelling toward Brooklyn, and therefore that the traffic at the New York end has raised that locality above the Fulton Street potential. Particularly is this the case when the bridge trains are operated entirely by electricity. Wherever the current leaves the bridge structure is the point to be watched. The cable anchorages, set as they are in masonry and concrete, seem to afford a rather poor exit for the current, for it is inclined to follow the traction cables into the termini. Important matters like this, however, should not be decided on speculation; it should be definitely determined just how much current enters the cables and where it is leaving them. It ought not to be a difficult matter to provide some immense copper clamps to grasp the cables just before they enter the anchorages and securely ground them, in this way deflecting the current from the anchorage proper, and, comparatively speaking, it should be an inexpensive undertaking.

The Bradford Tram Fatality.—At the resumed inquest last week in connection with the death from the electric tramcar accident in the city, Mr. W. J. Waugh, C.E., presented his report of an examination made on instructions from the coroner. He said that as the result of tests and his own experience in the working of tramways, he believed the car was equipped with sufficient brake power to keep it under control, and to bring it to a stand if intelligently used. The distance, however, in which that could be done in the case of a car having obtained considerable momentum was too great; in the case of hand brakes it was 160 yards, and in the case of electrical brakes 200 yards. He recommended the application of a slipper brake to each car and an increase in the supply of sand on each platform. The town clerk disputed Mr. Waugh's distance in tests, and said he had had the momentum of two cars, which was unfair. Finally it was agreed that other tests should be made on Mr. Waugh's plan, and such as the Corporation and the makers of the brake suggested. The inquest was resumed on Wednesday. Mr. Waugh's tests were made with a pilot car attached, but others were made by the Corporation and Westinghouse Electrical Company with a single car, and the distances of stopping were much less. The jury returned an open verdict, and added that Mr. Waugh's recommendations should be adopted, and that until they are the trams should cease running. On Wednesday afternoon the Corporation Tramway Committee met to consider the recommendations of the jury, and they decided that slipper brakes already ordered should be fitted as an additional protection to satisfy the public, and that additional sand boxes should be fixed. In view of the reports as to the efficiency of brake power and experiments by M. Regnier, of the Westinghouse Company, they, however, decided to take no action for stopping the service of cars.

Aluminium Conductors for Power Transmission.—We learn from an article in the New York *Electrical Engineer* that a scheme is being carried out which will bring the water power of the Snoqualmie Falls to the cities of Seattle and Tacoma, Wash. The company may furnish 4,000 kw. at Seattle and 2,000 kw. at Tacoma. The most important feature of the undertaking is the use of aluminium wire for the transmission line. Engineer Johnston says:—"We have succeeded in making contracts for a supply of aluminium wire at prices that make it cheaper than copper for our purpose. The metal we are to use will be of remarkably pure quality, being guaranteed to contain 99·30 per cent. of aluminium, and not more than 0·25 per cent. of iron and 0·30 per cent. of silicon. This will be alloyed with 1·50 per cent. of pure lake copper. We shall use about 150,000 lbs. of it." This is the first large transmission to use aluminium, and marks an important step in electrical engineering, for while aluminium has been talked of for some time for this purpose, price or some other factor seems to have stood in the way of its practical use to any extent over long distances. The pole line is for the most on the country roads, but in some cases a private right of way has been secured for a small sum. Large trees liable to fall on the line have all been cleared away. The poles were all purchased in the surrounding country. Wooden pins and cross arms will be used. Two circuits of three No. 2 aluminium wires each will run to Seattle, and two circuits of three No. 3 aluminium wires each will run to Tacoma. Thus each pole line will carry six wires. There will be two cross arms on a pole, and the pins will be arranged so as to bring the three wires of each circuit at the corner of an equilateral triangle. Triple petticoated porcelain insulators, known as the Redlands type because used on the Redlands, Cal., transmission, will support the aluminium conductors. Poles will be set about 120 feet apart.

Appointment Vacant.—A demonstrator is wanted for the City and Guilds Technical College at Finsbury to take charge of the laboratory classes in elementary electrical engineering and physical laboratory work, &c. See our "Official Notices" this week for particulars.

The Technical Separation of Copper.—During the electrolytic refining of copper the following foreign metals contained in the anode (crude copper) pass directly into the anode mud, viz.: silver, gold, platinum, bismuth, tin, arsenic, antimony, and lead; whilst others are only precipitated from the solution on long standing or after saturation. The more positive metals, nickel, cobalt, iron, and zinc, on the other hand, are dissolved out of the anode along with the copper, but are not deposited on the cathode owing to the low E.M.F. employed. The bath, which was originally an acidified copper sulphate solution, thus becomes richer in these positive metals and poorer in copper. If the anode contains much larger quantities of the positive metals than are usually found in crude copper, *e.g.*, German silver, brass (old cartridge cases), &c., then pure copper will be deposited on the cathode as before, provided the E.M.F. does not exceed that generally employed in the electrolytic refining of copper. The problem which B. Neumann recently set himself was to determine the effect of the large quantities of positive metals dissolved in the bath on the nature of the copper deposited on the cathode. The conclusions at which he has arrived may be summarised as follows:—Alloys of copper with the more positive metals, nickel, cobalt, iron, zinc, and aluminium, may be refined in the ordinary way. The copper only is deposited on the cathode, whilst the other metals remain in solution. The E.M.F. per bath should not much exceed 0·5 volt. As the electrolysis proceeds the resistance of the electrolyte increases, owing to its becoming poorer in copper and richer in the other metals, and for this reason the efficiency of the current falls. But not only is this so, but the quality of the copper deposited gets worse and worse, so that practically the electrolysis must be stopped at a certain point. The experiments of Forster and Seidel have shown that the precipitation of brownish-red powdery copper is connected with a certain low concentration of the copper ions in solution, and, hence, during the refining of the above alloys, a point must ultimately be reached when spongy copper is deposited. Addition of more free sulphuric acid can in no way prevent this. According to the law of mass action it would rather tend to facilitate the formation of spongy copper. This being so, the suggestion of certain authors to employ nothing but sulphuric acid in the bath is misleading. Starting with a bath containing sulphuric acid only, the copper obtained by the author still remained spongy in texture, even after the electrolysis had been allowed to proceed for 20 hours. It has also been stated that during the refining of the above alloys the bath ultimately becomes entirely free from copper. This is not borne out by actual experiment, and the author considers it cheaper to remove the remainder of the dissolved copper by means of sulphuretted hydrogen than by the introduction of insoluble anodes, or anodes composed of the more positive metals. Since an Austrian firm has succeeded in electrolytically refining crude copper containing 20 per cent. of impurities, the author considers that Canadian nickel ore will probably, in the near future, become of greater importance, if it can be treated in a similar manner. The above is an abstract of a paper in the *Zeitschrift für Elektrochemie*, iv., 316—322 and 333—338, by B. Neumann.

American Amalgamation.—The rumour circulated some weeks ago of the amalgamation of the Westinghouse Electrical Company, of Pittsburg, and the Walker Electrical Company, of Chicago, seems to be quite correct. The American electrical papers give details of, and make comments upon, the amalgamation. It is stated that the combination will prevent further patent litigation between the two parties, and as the Westinghouse Company and the General Electric have an agreement, there may be peace and low legal expenses for the three concerns. The lawyer has made many thousands of dollars out of some of these companies in the past, but in the future he will be comparatively briefless, so far as they are concerned, and perhaps the poor shareholder will, in a small measure, be gainers.

Electric Launches in Ceylon.—Three electric launches are to supersede the present steamboats plying on the lake between the Pettah and Slave Island.

Appointments.—Mr. W. Beckit Burnie has been appointed to the vacant Senior Demonstratorship in Electrical Engineering at the South Western Polytechnic, Chelsea. Mr. Burnie has studied at the Nottingham University College, under Prof. Ayrton at the Central Technical College, under Prof. Weber, of Zurich, and has been employed by Messrs. Laurence Scott & Co., and by Messrs. Siemens Bros. and Co.

The directors of the Glasgow and South-Western Railway have appointed Mr. George Russell (who has acted as interim telegraph superintendent for the last 12 months) to be telegraph superintendent of the company.

The Civil Engineers' Examination.—There has been arranged at the Battersea Polytechnic a special course of evening classes in preparation for the examination of the associate membership of the Institution of Civil Engineers. Instruction is being given in theoretical and elementary applied mechanics, the theory of structures and the strength and elasticity of materials. The classes, which commenced on September 26th, are being conducted by the Principal, Mr. S. H. Wells, and others.

The Proposed New Physical Laboratories for the Owens College.—On Tuesday, the 4th inst., the foundation stone of the new physical laboratories for the Owens College, Manchester, was laid by Mr. Henry Simon. The new laboratories will, when completely, be the finest of their kind in the country, the estimated cost for building and equipment being £30,000, and the ground area being exceeded only by the physical laboratories of the John Hopkins University of Baltimore, and the Darmstadt Polytechnic. The Owens College is indebted to the generosity of two anonymous donors, who have given respectively £10,000 and £5,000, to Dr. Ludwig Mond and Mr. Henry Simon, who have each contributed the sum of £1,000 towards providing these magnificent laboratories. In Prof. Schuster, Owens College is fortunate in possessing one who does his utmost to encourage individuality of character and originality of thought in the students committed to his care. He realises that the value of education cannot be estimated by university degrees, but by its effect in producing men capable of benefiting their fellow creatures. In these new laboratories, which will be under the direction of Prof. Schuster, the commercial applications of electricity will occupy a prominent place, and a special feature will be the provision for large currents for electrical furnace work. Electrical engineering merits a department of its own in an important centre like Manchester, and it is to be hoped that before long Owens College may be enabled to further the progress of electricity in its applications to commerce to a still greater extent by the establishment of such a department and by encouraging a full undergraduate course in the subject.

The Aron Electricity Meter.—The company which is being brought out to further exploit this meter has, we think, a good thing in hand. The meter as now made is self-winding, reads direct in B.T. units, and having been in use for several years, defects which were found to exist in the original apparatus have been weeded out, so that the instrument may now be considered as quite reliable; in principle it is thoroughly sound. The capital, £250,000, may be considered high, but it includes the business throughout the world. It is interesting to note how the reviewer of style rather than of matter in the "Society" paper of *the* profession, has completely climbed down from the lofty position to which he soared last week with regard to this venture. Then he could not by any means recommend it; now he cannot find words enough with which to sing its praises. What has happened in the interim?

Since When?—"W. M. M." wishes to know "since when has 'dissipate' been an intransitive verb?" We would also like to ask since when has "the more part of it might have been written any time in the last 15 years" been considered a good example of English as she is written?

NEW COMPANIES REGISTERED.

Marquand Accumulator Company, Limited (58,923).—This company was registered on September 26th, with a capital of £20,000 in £10 shares, to enter into an agreement with A. J. Marquand and the Electric Insulation Syndicate, Limited, and to carry on the business of electricians, electrical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—J. Guthrie, Kynin Terrace, Penarth, shipowner; L. B. Atkinson, Western Mail Buildings, Cardiff, civil engineer; M. Gunn, Mount Stuart Square, Cardiff, shipowner; T. McM. Heywood, Thornlibank, Cardiff, ship broker; F. Marson, Tillington House, Cardiff, gentleman; P. A. V. Robinson, Cardiff, merchant; A. J. Marquand, 2, Dock Chambers, Cardiff, engineer. The number of directors is not to be less than three nor more than eight; the first are Lord W. Beresford, M. Gunn, H. B. Marquand, F. Marson, T. McM. Heywood, J. W. Palmer, L. B. Atkinson, and A. J. Marquand; remuneration, £300 per annum, divisible. Registered office, 2, Dock Chambers, Cardiff.

Medical Battery Company, Limited (58,940).—This company was registered on September 27th, with a capital of £5,000 in £1 shares, to acquire the rights, copyrights, patents, and businesses formerly owned and carried on by Cornelius B. Harness, and to carry on the business of electrical appliance manufacturers, and proprietors of electrical and mechanico-therapeutical institutions. The subscribers (with one share each) are:—C. B. Harness, 21, Baker Street, W., gentleman; L. F. Aspinall, 8, Park Lane, Leeds, electrician; H. C. Simmonds, 4, Newman Street, W., gentleman; G. W. Hare, 9, Park Terrace, W., clerk; J. Alexander, 44, Summerley Street, Earlsfield, S.W., engineer; W. Shields, 1, Dryden Mansions, West Kensington, accountant; H. Russell, 7, Goldsmith Road, Acton, secretary. The number of directors is not to be less than two nor more than five. The first are C. B. Harness, and another to be afterwards appointed. Remuneration, 5 per cent. of the net profits divisible.

Electric Lamp Supply Company, Limited (58,944).—This company was registered on September 27th, with a capital of £10,000 in £1 shares, to acquire the business carried on at 60, Queen Victoria Street, E.C., as "The Electric Lamp Supply Company," to enter into an agreement with A. M. Day, and to carry on the business of manufacturers of, agents for, and dealers in electric lamps, plant, apparatus, &c. The subscribers (with one share each) are:—A. W. Maxwell, 148, Burnt Ash Hill, Lee, secretary; H. Maxwell, Holmbury Cottage, Hook End, Surbiton, publisher; A. V. Smith, 19, Liverpool Road, Thornton Heath, tea broker; A. M. Day, 60, Queen Victoria Street, E.C., electrical engineer; R. J. Dale, 55, North End Road, West Kensington, agent; G. Pistell, 7, South Norwood Hill, electrician; E. W. C. Patten, 72, Salmon Lane, Limehouse, E., clerk. The number of directors is not to be less than two nor more than five; the first are A. W. Maxwell, H. Maxwell, and A. M. Day; qualification, £100. Registered office, 60, Queen Victoria Street, E.C.

Universal Electrical Advertising Syndicate, Limited (58,960).—This company was registered on September 28th, with a capital of £20,000 in £1 shares, to enter into an agreement with R. Halford, G. Wigley, A. J. Chamberlain and A. E. Blake, and to carry on the business of advertisers by means of electricity or otherwise, advertisement contractors, mechanical and electrical engineers, and electrical apparatus makers. The subscribers (with one share each) are:—A. J. Chamberlain, St. Peter's Church Walk, Nottingham, chartered accountant; A. E. Blake, Prudential Buildings, Nottingham, stockbroker; R. Halford, St. Peter's Church Walk, Nottingham, estate agent; G. Wigley, Warser Gate, Nottingham, silk merchant; F. Marchant, St. Peter's Church Walk, Nottingham, chartered accountant; W. M. Hicking, Queen's Road, Nottingham, lace dresser; A. O. Hines, Egypt Road, New Basford, clerk. The number of directors is not to be less than two nor more than six; the subscribers are to appoint the first; qualification, £250; remuneration as the company may decide.

Drake & Gorham Electric Power and Traction Company, Limited (58,963).—This company was registered on September 28th, with a capital of £250,000 in £1 shares, to enter into an agreement with the Drake & Gorham Electric Power and Traction (Pioneer) Syndicate, Limited, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—R. Dand, 52, Durham Road, Manor Park, E., secretary; C. S. Oxenburgh, 81, Ramsden Road, Balham, S.W., gentleman; F. K. King, 19, Edna Street, Battersea, S.W., clerk; J. S. Hyslop, 37, Herrick Road, Highbury, N., clerk; W. R. Long, 67, Mildmay Grove, N., clerk; J. Crowther, Albert Square, Altrincham, secretary; A. M. Taylor, 62, Heathwood Gardens, Charlton, engineer. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first; qualification of first directors, £100, of others, £500; remuneration, £100 each for the first year, and £1,500 per annum divisible afterwards.

Crowdus Accumulator Syndicate, Limited (58,966).—This company was registered on September 29th, with a capital of £50,000 in 35,000 £1 shares, and 30,000 10s. shares, to enter into an agreement with Max Friend, and to carry on the business of electricians, suppliers of electricity, and manufacturers of, and dealers in, electrical plant, batteries, dynamos, engines, motors, cycles, carriages, &c. The subscribers (with one share each) are:—J. T. Bowden, merchant; W. A. Crowdus, electrician, and E. F. Sheridan, attorney-at-law, all of 15, Copthall Avenue, E.C.; Max Friend, 32, Billiter Buildings, E.C., merchant; O. R. Slacke, Kt., C.B., 111, Piccadilly, W.; J. B. Martin, 36, Victoria Street, S.W., landowner; D. H. S. Alldridge, 28, Victoria Street, S.W., gentleman. Registered without articles of association.

Imperial Tramways Company, Limited (58,981).—This company was registered on September 29th, with a capital of £300,000 in £10 shares (10,000 £6 per cent. cumulative preference) to enter into an agreement with a company of the same name and its liquidator, to acquire, equip, work, and maintain any railways (including light railways), tramways and omnibus undertakings, and to carry on the business of an electric lighting company. The subscribers (with one share each) are:—Geo. White and Samuel White, Clare St. House, Bristol, stockbrokers; J. C. Robinson, 88, High Road, Chiswick, W., civil engineer; H. C. Godfray, 60, Finsbury Pavement, E.C., solicitor; E. Everard, Broad Street, Bristol, printer; C. Challenger, Tramways Centre, Bristol, manager; S. Hare, Maryleport Street, Bristol, chartered accountant. The number of directors is not to be less than two nor more than four. The subscribers are to appoint the first; qualification, £500; remuneration as the company may determine.

Anglo-Cuban Syndicate, Limited (58,999).—This company was registered on September 30th, with a capital of £50,000 in £1 shares (5,000 founders'), to construct, execute, build, carry out, equip, and maintain telegraph cable or telephone services, railways, stations, warehouses, tramways, docks, harbours, piers, water works, markets, bridges, &c., in Cuba or elsewhere. The subscribers (with one share each) are:—A. J. Secretan, 54, Old Broad Street, E.C., accountant; C. H. Yarmouth, 3, Sandwell Mansions, West Hampstead, merchant; W. A. Leigh, 1, Beechfield Road, Catford, S.E., clerk; J. H. Brodie, 57, Holly Park Road, New Southgate, N., gentleman; F. W. White, 8, High Street, Highgate, N., secretary; H. S. Fleming, Park House, Ingrave, Brentwood, major; T. G. Hensler, 2, Gisburn Road, Hornsey, N., gentleman. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £10; remuneration, £100 each per annum.

Eastern Telegraph Company.—The board announce the payment on 14th prox. of a dividend at the rate of 3½ per cent. per annum, less income-tax, on the preference stock for the quarter ending September 30th, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended June 30th last.

British Columbia Electric Railway Company, Limited.—The half-yearly interest on the 4½ per cent. debentures, due 15th inst., will be paid on and after that date at the offices of Messrs. Sperling & Co., 8, Austinfriars, E.C.

Stock Exchange Notice.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Metropolitan Electric Supply Company, Limited—Further issue of 22,500 ordinary shares of £10 each.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending September 28th, 1898, were £2,958 7s. 3d.; corresponding period, 1897, £2,712 13s. 10d.; increase, £245 13s. 5d.

The City and South London Railway Company.—The receipts for the week ending October 2nd, 1898, were £955; week ending October 3rd, 1897, £926; increase, £29; total receipts for half-year, 1898, £13,269; corresponding period, 1897, £12,621; increase, £648.

The Dover Corporation Electric Tramways.—The receipts for the week ending October 1st, 1898, were £209 5s. 8d.; week ending October 2nd, 1897, £146 5s. 11d.; increase, £62 19s. 9d.; total receipts to October 1st, 1898, £6,416 15s. 4d.

The Dublin United Tramways Company.—The receipts for the week ending September 30th, 1898, were as follows:—D. U. T. Co., horse cars, £2,390 16s. 5d.; ditto, electric cars, £421 16s. 10d.; D. S. D. Co., electric cars, £870 2s. 9d.; total, £3,682 16s.; corresponding week last year—D. U. T. Co., horse cars, £2 919 8s. 3d.; D. S. D. Co., electric cars, £585 2s. 2d.; total, £3,504 10s. 5d.; increase, £178 5s. 7d.; aggregate to date, £57,890 14s. 11d.; aggregate to date last year, £53,403 3s. 7d.; increase to date, £4,487 11s. 4d. Worked:—The mileage open is 13 miles electrically, 31 miles by horses, as against 8 miles electrically, and 34 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending October 2nd, 1898, amounted to £1,597; corresponding week last year, £1,350; increase, £247.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending September 30th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,380.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Sept. 28th.	Closing Quotation, Oct. 5th.	Business done during week ended Oct. 5th, 1898. Highest.	Lowest
137,400£	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
923,960£	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	63 — 66	63 — 66	63½	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	115½—116½	115½—116½	116¼	116
3,038,020£	Do. do. Deferred...	Stock	...	...	...	15¼— 16¼	15¼— 16¼	...	...
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¾— 16¼	15¾— 16¼	16⅛	15⅞
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	111 —115	111 —115	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	104 —106 xd	105¾	105
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	8½— 9½	8½— 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11 xd	...	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	103 —106%	103 —106%	...	...
60,710£	Direct United States Cable	20	2½ %	2½ %	...	11½ — 12	11½ — 12	11 1/16	11¾
120,000	Direct West India Cable, 4½ % Reg. Deb. ...	100	...	...	...	100—103	101 —104	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½ %	6½ %	7 %	17⅝— 18¼	17⅝— 18¼	18 1/16	17⅝
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	105 —108	105 —108	106¾	105¾
40,000	Do. Prov. Certs., 50 % paid	...	...	...	...	52 — 55	52 — 55	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —130	126 —130	127¾	..
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17⅞	17⅝
25,200£	{ Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326 }	100	5 %	5 %	5 %	99 —103	100 —104	...	...
100,500£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	100 —103	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —129	125 —129	127½	...
35,100£	{ Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5 %	...	99 —103	100 —104	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	100 —103	101 —104	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	102 —105	102 —105	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	12 — 12½	12 — 12½	12¼	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	17⅛	16¾
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	28½— 29½	28⅝	...
160,000£	Do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	101 —104	101 —104	...	...
97,000	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	100 —104	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	51 — 54	51 —54	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs. ...	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5⅛ %	5⅛ %	6 %	5⅜— 5⅝	5⅜— 5⅝	5⅛	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	12 — 14	13¼	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5⅜	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100—105	100 —105	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4⅜	4¼— 4⅜	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	103 —106	103 —106	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400£	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	100	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ¾	¼— ¾	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	104 —107	104 —107	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	12 — 12½	12¼— 12⅜	12⅜	12⅜
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½ %	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	107 —110	107 —110	107½	...
88,321	West India and Panama Telegraph	10	⅞ %	1 %	⅞ %	1 — 1¼	1 — 1¼	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	9¼— 9⅜	9¼— 9⅜	9½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	7 — 9	7 — 9	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	106 —109	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	105 —110	105 —110	...	...
160,100£	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	...	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	9 — 10	9 — 10	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	113 —115	113 —115	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25 9/16	25
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	24 — 25	24 — 25	24	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	16¾	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	125 — 130	125 —130	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £8 paid.	10	...	...	...	8½— 9½	10½— 11½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14½— 15½	15	14¾
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5¼— 5⅜	5¼— 5⅜	5⅜	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	9½— 10½	9½— 10½	10	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17 — 18	17 — 18	17½	17
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	116 —120	116 —120	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	15½— 16½	15½— 16½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7¼ %	10½ %	14½ %	17 — 18	17 — 18	17⅜	17¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9½	9⅜
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	105 —108	105 —108	106	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	3 1/16	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	16 — 17	16⅝	16¼

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Sept. 28th.	Closing Quotation Oct. 5th.	Business done during week ended Oct. 5th, 1898. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	2⅞— 3⅛	3 — 3¼	3 1/16	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —102	94 —100 xd	...	...
30,000	British Electric Traction	10	...	...	...	16½— 17	16¾— 17¼	17	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 14	13 — 14	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½ %	*nil*	*nil*	1⅝— 2	1⅝— 2	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	107 —111 xd	107 —111	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	102½	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	10 — 11	10 — 11	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110 —113	110—113	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10½	10⅜
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	6⅝	6 5/16
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅝	1¼— 1⅝	1⅝	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4½— 5	4½— 5	4⅞	4⅝
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 1/16 %	1⅛ %	70 — 72	70 — 72	71½	70¾
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £3 pd.	10	...	...	...	2⅜— 3¼	2⅜— 3¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1¾— 2¼	1¾— 2	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	89 — 94	90 — 95	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½ %	6 %	2¼— 2⅜	2¼— 2⅜	2⅝	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½ %	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	101 —103	101 —103	101¼	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2⅛— 2⅜	2⅛— 2⅜	2¼	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	2⅞— 3¼	2⅞— 3¼	3	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅝— ⅝	⅝— ⅝	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½ %	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	20½— 21½	20½— 21½	20⅝	20¾
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	18¼	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	4½ %	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	22½— 23½	22½— 23½	23⅜	22¾
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105 xd	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅝ %	2⅝ %	3¼ %	10 5/16— 10 7/16	10 7/16— 10 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16	15½— 16	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	39 — 43	39 — 43	40¾	39¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	100 —103	100 —103	...	...
540,000	Waterloo and City Railway, Ord. Stock	100	...	...	...	125 —130	117 —122	125½	119½

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10¼.
British Aluminium, Ordinary, 10½—11½; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 106—109.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 14—15; 1st Preference Cumulative 6%, £5 (fully paid), 7¾—8¼. Debentures, 107—109. Dividend, 1897, on Ordinary Shares 10%.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3¾—4.
National Electric Free Wiring, 10s. paid, ⅜—½.
*T. Parker, £10 (fully paid), 13—13½.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 7¾—8¼. Dividend for 1896—6%.

Bank rate of discount 3 per cent. (September 22nd, 1898).

MARKET QUOTATIONS, Wednesday, October 5th.

	CHEMICALS, &c.		This week.	Last week.	Increase or Decrease.
a	Acid, Hydrochloric	per cwt.	5/-	5/-	..
a	„ Nitric	per cwt.	22/-	22/-	..
a	„ Oxalic	per cwt.	32/-	32/-	..
a	„ Sulphuric	per cwt.	5/6	5/6	..
a	Ammoniac, Sal	per ton	37/-	37/-	..
a	Ammonia, Muriate (grey) ..	per ton	£19	£19	..
a	„ „ (white) ..	per ton	£26	£26	..
a	Bleaching powder	per ton	£6 15	£6 15	..
a	Bisulphide of Carbon	per ton	£15	£15	..
a	Borax	per ton	£14 10s.	£14 10s.	..
a	Benzole (90 %)	per gal.	7/-	7/-	..
a	„ (50/90 %)	per gal.	5/6	5/6	..
a	Copper Sulphate	per ton	£17	£17	..
a	Lead, Nitrate	per ton	£23 10s.	£23 10s.	..
a	„ White Sugar	per ton	£30 10s.	£30 10s.	..
a	„ Peroxide	per ton	£27 10s.	£27 10s.	..
a	Methylated Spirit	per gal.	2/9	2/9	..
a	Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a	Potash, Bichromate, in casks..	per lb.	3¾d.	3¾d.	..
a	„ Caustic (75/80 %) ..	per ton	£24	£24	..
a	„ Bisulphate	per ton	£35	£35	..
a	Shellac	per cwt.	64/-	64/-	..
a	Sulphate of Magnesia	per ton	£4 10	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	£6 10	..
a	„ Recovered	per ton	£5 10	£5 10	..
a	„ Lump	per ton	£5	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£8 15	£8 15	..
a	„ Crystals	per ton	£3	£3	..
a	„ Bichromate, casks ..	per lb.	3d.	3d.	..

	METALS, &c.		This week.	Last week.	Increase or Decrease.
b	Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b	„ Sheet, in ton lots..	per ton	£191	£191	..
c	Brass (rolled metal 2" to 12") basis	per lb.	6¼d.	6¼d.	..
c	„ Tube (brazed)	per lb.	8¼d.	8¼d.	..
c	„ Wire, basis	per lb.	6¼d.	6¼d.	..
f	Ebonite Rod	per lb.	3/-	3/-	..
f	„ Sheet	per lb.	5/-	5/-	..
g	Copper Bars	per ton	£62	£62	..
g	„ Wire (basis price) ..	per lb.	7¼d.	7¼d.	..
g	„ Sheet	per ton	£62	£62	..
g	„ Rod	per ton	£62	£62	..
n	German Silver Wire	per lb.	1/6	1/6	..
h	Gutta-percha, fine	per lb.	5/6	5/6	..
h	India-rubber, Para fine ..	per lb.	3/10½forw'rd	4/- forw'rd	1½d. dec.
i	Iron, Charcoal Sheets	per ton	£18	£18	..
i	„ Pig (Cleveland warrants)	per ton	43/8	43/4½	3½d. inc.
i	„ Forgings, according to size	per ton	From £11	From £11	..
i	„ Scrap, heavy	per ton	45/- nom	45/-	..
i	„ Wire galvanised No. 8 ..	per ton	£8 15	£8 15	..
g	Lead, English Ingot	per ton	£13	£18	..
g	„ „ Sheet	per ton	£14	£13 17 6	2/6 inc.
l	Mica	per lb.	5/6	5/6	..
m	Manganin Wire No. 28.. ..	per lb.	8/-	8/-	..
g	Mercury	per bottle	£7 4	£7	4s. inc.
o	Platinum	per oz.	£2 16	£2 16	..
i	Steel, Magnet, according to description	per ton	From £15	to £40	..
i	Steel, Magnet, in bars		£58	£58	..
g	Tin, block	per ton	£78	£76 10	£1 10s. inc
g	„ foil	per lb.	1/3	1/3	..
j	Yarns, Cotton, Single 10lb. bundles	pr lb.	6¾d.	6¾d.	..
j	„ Flax, 6 or 8 lea... ..	per lb.	3¾d.	3¾d.	..
j	„ Hemp, 3 ply 10 lbs. ..	per lb.	3½d.	3½d.	..
j	„ „ Russian, 10 lbs.	per lb.	4½d.	4½d.	..
j	„ Jute, 180 lbs. rove ..	per ton	£11 10	£11 10	..
j	„ Manila, 24 thread ..	per ton	£31	£31	..
k	Zinc, Sheet (Vielle Montagne brand)	per ton	£26	£26	..

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd.
c „ „ „ Messrs. Thos. Bolton & Sons,
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co, Ltd
g „ „ „ Messrs. James & Shakspeare.
h „ „ „ Jackson & Till.
i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
„ „ „ „ Sanders, Wake & Co.
m „ „ W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
Johnson Matthey & Co.

LONDON UNITED TRAMWAYS TRAMWAY SCHEMES.

With reference to the London United Tramways Company's crusade in favour of electric traction for London systems, the following is a copy of a communication addressed by Mr. J. Clifton Robinson, managing director and engineer to the company, to the Clerk of the London County Council:—

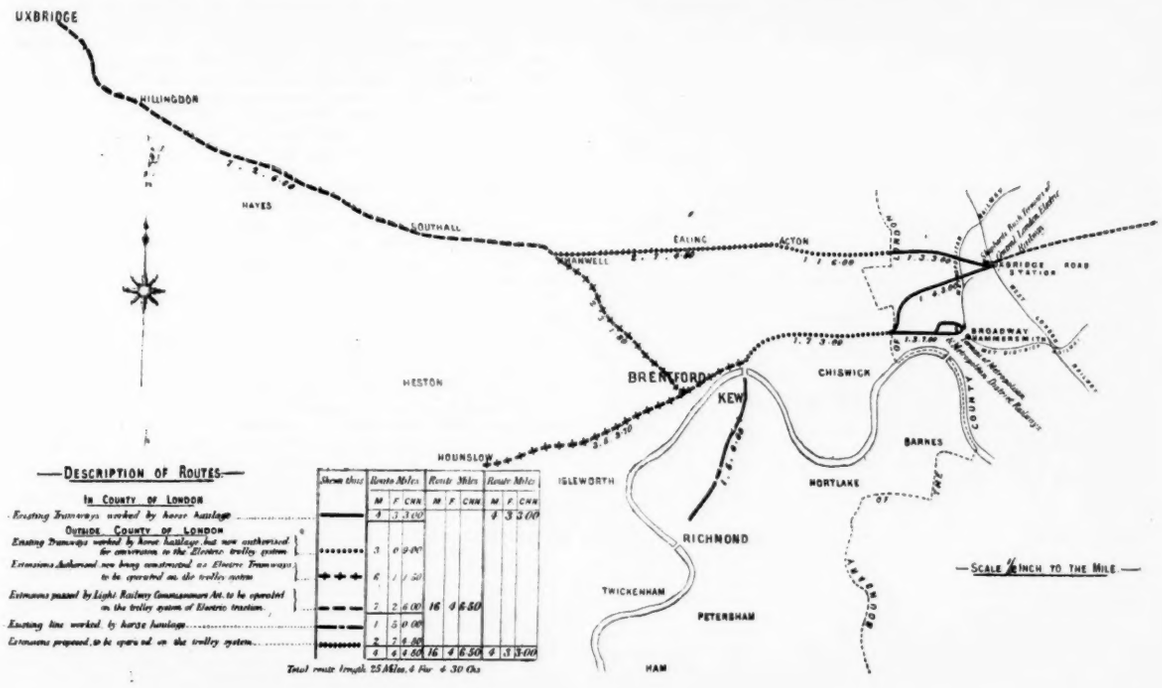
"The directors of the London United Tramways are now engaged in carrying out the conversion and extension of the system authorised under their Act of the past session and the introduction thereon of overhead electric traction. It will be within the recollection of the London County Council that the three short portions of the company's system lying within its jurisdiction were omitted from the company's Bill as regards the compulsory introduction of the overhead trolley system of electric traction, while this method of traction was sanctioned, and is now being adopted, on the remainder of the company's existing lines and extensions.

"These other tramway lines, existing and authorised (including the light railway to Uxbridge which the Light Railway Commissioners have passed) extend to about 20 route miles, the whole of which it is expected will be completed, and the electric power thereon put in operation, by June of next year.

"There remain three fragments of tramway belonging to the company which lie within the London County Council's district, namely:—

	m.	f.	chs.
"1. From the Askew Arms to Uxbridge Road Station	1	3	3
"2. From Uxbridge Road Station by Goldhawk Road to Young's Corner ...	1	4	3
"3. From Hammersmith Broadway to Young's Corner	1	3	7

a total of about four miles in all, or one-sixth of the whole route covered by the company's new and existing lines.



"A route plan is sent herewith (reproduced above) showing the extent of tramway on which electric traction has been authorised, and indicating the three terminal fragments lying between the system and London, for the electric equipment of which the Council's assent is now sought.

"In view of the extreme disadvantage to the public of having these three 'dead ends' to an otherwise through and complete system worked by horse haulage, in place of enjoying one unbroken mode of traction from end to end of the lines, the directors have instructed me once more to approach the Council asking its further and best consideration of this important public matter. They are the more readily induced to ask for this reconsideration in view of the tramway obligations now being undertaken by the Council. They feel that the system now belonging to the company if completed as desired, would be in many ways of value to the Council, as the directors confidently point to their operations elsewhere as demonstrating the superiority of the overhead trolley system over every mode of mechanical traction now known.

"It may be pointed out that the introduction of this method of working on these three short terminal parts of the company's completed system would not involve any question as to the right of the Council to purchase the lines at the expiration of the period of 21 years, *i.e.*, in 1908. So far from that being the case, the directors, with a view to facilitate an arrangement, would be prepared to hand over to the Council, free of charge, the whole property to the feeder cables, or mains laid down in the streets, together with the standards and overhead wires there, thus leaving the question of the purchase of the permanent way, &c., under the purchase clauses of the Tramways Act, 1870, absolutely unprejudiced.

"The directors would further be willing to enter into an agreement to remove the standards and other electric apparatus, at any time during the currency of the present term, on receiving a year's notice from the Council so to do. The company would also undertake to adopt, subject to the approval of the Board of Trade, any other mode of traction which the Council may at any future time find in practical operation and acknowledged to be superior to and more efficient than the overhead trolley system, or, further, should the London County Council at any time extend tramways to be hereafter acquired or constructed by the Council so as to connect up with any of these portions of the London United Tramways, situated within the County of London, the company would then, if required by the Board of Trade, adopt on these lines such method of mechanical haulage as the Council may have adopted on the tramway lines with which such connections are made.

"The whole of the company's existing tramways having recently been reconstructed on the most improved and modern lines (having in view the eventual adoption of electric traction), no alteration or conversion of the permanent way would be necessary, and the work of erecting the standards, laying the feeder cables, and placing in operation the overhead trolley wires would be a simple matter, involving not more than a month's work.

"The directors approach the London County Council in this matter fortified by the approval of the Vestry of Hammersmith, as the local authority more immediately concerned, and they respectfully urge the Council to give effect to the proposal now put forward for the following reasons:—

"1. Parliamentary sanction to the introduction of electric traction on the company's lines was accompanied by a very strong expression of opinion in favour of this system on the part of an admittedly strong Committee of the House of Commons.

"2. Serious inconvenience will accrue to the travelling public if at the three termini of a large system of tramways a break in the method of haulage is encountered, cutting off direct communication with the points on which the company's traffic naturally converges.

"3. While overhead electric traction is acknowledged at present as the most efficient, safe, and convenient method of haulage in existence, the directors offer such conditions as would compel them to adopt on these lines, on the County Council requiring them, any newer invention proving more efficient, economical, or acceptable.

"4. The terms on which the directors offer, and are prepared to accept for the assent of the County Council are such as to preserve in every way the statutory right of purchase held by the Council, and to leave the control of the streets unaffected in the Council's hands.

"5. As the work with the remaining 20 miles of the company's lines will, it is expected, be completed in June next, an early determination of the matter now in hand would be distinctly for the public advantage.

"I shall be glad to have the pleasure of appearing before the Council, or any committee of the Council appointed for the purpose, when I shall be ready to submit such further information and explanation of our proposals as may be deemed necessary."

ELECTRICAL ENGINEERS' SPECIFICATIONS.*

By J. ALEXANDER McLAREN.

This subject is one which covers a great deal of ground, and with the limited time at our disposal, we cannot pretend to go thoroughly into the matter, or even mention all the items contained in the specification of an electrical engineer, but will just touch here and there on some of the most interesting features. Electricians are a long, long way from the time that they often look forward to, and sometimes talk about, when they will be able to dispense with the services of the mechanical engineer, and if you open one of their specifications, you will at once notice that by far the largest part is devoted to the mechanical side of the subject, and only a comparatively small space is taken up by the purely electrical section. Properly speaking, the correct title for this paper should have been the "Mechanical Section of Borough Electrical Engineers' Specifications." I have inserted the word borough advisedly, as it is the borough electrician who produces the thickest specifications. There is a considerable difference in the position of a borough electrical engineer and the man who looks after the interests of a company. The former individual is one who is hopelessly bound round with red tape; he is answerable for all his doings to a committee, which, at the best, is only possessed of that dangerous thing "a little knowledge," whose members very often adorn such professions as publicans and butchers, and occasionally none at all.

A committee such as this, which does not know the difference between a cable and its insulation, but thinks it does, is necessarily an awkward one to deal with, and the omission on the part of the engineer of steam traps or oil filters is as great a sin in its eyes as though he had forgotten to stipulate that the engines should govern well. On the other hand, the engineer to a private company is a man possessed of power, his word is law as long as he produces a good dividend along with the electricity, and if he likes he can practically dispense with such unprofitable things as specifications.

When a corporation decides to go in for electricity, the first thing to be done is to call in the services of an electrician. They have two ways of doing this. First, by inviting the services of one of our well-known consulting engineers, who will take charge of the whole affair, and afterwards recommend a man to run the station when it is completed. Second, by advertising for a borough electrical engineer who shall conceive the system, lay out the station, and afterwards remain as engineer. When the man is a capable one, the second method is best, as he knows all the ins and outs of the undertaking, is on the spot to see that everything is right to begin with, and does his very best to keep a constant light at an even voltage, and to make the concern pay. His reputation is at stake, his work is watched by all his contemporaries, and if his labour is rewarded by success he will quickly have earned for himself a reputation in the electrical world that will stand him in good stead when he wants to get a little nearer the top of the tree, where, it is said, there is so much more room.

Whereas in the first case when the borough engineer has been placed by the consulting engineer after all the work has been done, he takes office with no responsibility as to the suitability of the system or the quality of the work, and, whenever anything goes wrong, he appears before his committee with a light heart and an infallible excuse that this mishap would never have happened if the concern had only been properly designed.

When the applicant, having satisfied the Council with his credentials, and brought all the influence he could command to his aid, receives the post, the first thing to be done is to decide which is the best system of lighting for the particular town, then to get at the amount of money necessary, which is easily enough got, for all he has to do is to write to a few engineers, boiler makers and electricians for quotations for certain sizes of machinery and quantities of material, which he will get by return of post, and also unsolicited visits from members of the firms in the course of the next few days. Then, having recommended to his committee that a certain sum is necessary, he gets instructions to get out specifications and ask for tenders, and now is the time to make himself famous.

His one object is to make his specification as voluminous as possible, so as to impress his wondering committee; he invariably succeeds in this, and produces a book of about 80 pages, foolscap size, well bound, the charge of which varies from one to three guineas, which, however, is returned on receipt of a *bonâ fide* tender. In filling this book, he is ably assisted by the town clerk, who, between them, draw out a number of wordy clauses, numbering, sometimes, as many as 44, setting forth the conditions under which the contractors must work. I cannot pretend to go through these clauses to-night, or there would be no time left for anything else. But I will say that these clauses which are so manifestly one-sided, so carefully worded, which go to protect the corporation against every conceivable contingency, that the wonder is that any firm agrees to be bound by them. When a contractor signs his name to be bound by these conditions, he practically gives up all liberty, and leaves himself entirely at the mercy of the borough engineer, as the following clause will show:—

"The works generally, and every part thereof, shall be executed and completed, and the provisions of the specification complied with to the satisfaction of the engineer, and in all cases of difference of opinion, as to the manner in which the works are executed, or as to the quality of the materials, or as to the true intent and meaning of this specification or the said drawings, or as to any matter of charge or account or otherwise, as between the corporation and the contractor, either during the progress or after the completion of the work, the decision of the engineer shall be final and binding on both parties."

On looking through these famous clauses, one would think that it would be by the purest accident that the contractors got paid at all, and it would only be by good luck that they escaped paying the corporation some indemnity. As a matter of fact, familiarity in this case brings its usual result, and these formidable clauses are generally just taken as read, and are referred to as "clauses of the usual significance." The only ones a tenderer spends any time over are those relating to "time of delivery," "penalties," and more especially to terms of payment.

Penalties.—There is usually a penalty put against bad delivery, but as a rule, it is not abnormal. A curious fact in connection with penalties is, according to law, the payment of a penalty cannot be enforced, unless it is claimed as ascertained liquidated damages; in the later specifications it is put in that form. It very often is stipulated that if the plant used any more steam than a certain amount per kilowatt or per I.H.P., that a penalty of so much per pound will be enforced. As a set-off against this, the purchasers appear to be very generous, by offering the contractor a bonus for every pound of steam under that figure, but take care to make it so low, that there is no chance of any bonus changing hands. For instance, the Yorkshire House-to-House Company offered a bonus of "£200 pounds per pound, or *pro rata* for every complete tenth part of a pound for every pound or part of a pound under 14½ 'lbs. per I.H.P.'" That was for a compound engine, running at 100 revolutions, 125 lbs. pressure, and the water was measured into the boiler. In short, they put the amount of steam at such a low figure, that the contractor will be lucky if he reaches it, and stick on a penalty for anything above it, and a bonus for anything below it, so that here again the manufacturer has everything to lose and nothing to gain.

Terms of Payment.—This is a clause that is always examined, and it often requires to be done carefully. It does not do to be in a hurry when you want to know how you are going to be paid—for example, Derby Corporation tells you in this manner—Clause 37: "That, subject to the conditions herein contained, the contractor shall be entitled to payment for his work in manner following, that is to say, to a monthly instalment equal to 80 per cent. of the *primâ facie* value (as far as the same may then be ascertained) of the amount of work executed in the then preceding month, to a further instalment of 10 per cent. of the *primâ facie* value (as far as the same may then be ascertained) of the amount executed when such works have been completed, and delivered to and accepted by the corporation, in manner aforesaid, and to the balance, whatever the same may be found to amount to, so soon as the responsibility of the contractor shall have ceased and been determined. Provided that no sum or sums of money shall be considered to be due or owing; nor shall the contractor make or enforce any demand upon or against the corporation for or on account of any work executed by him, unless the contractor shall have delivered from time to time, and at all times, within one week from the expiration of the month in which the amount of work then claimed for has been performed, a true and proper claim, or true and proper claims. Nor unless the engineer shall have certified or recommended the amount to be paid as such instalment or balance to the contractor, and that the contractor is reasonably entitled to such instalment or balance respectively, nor unless such certificate shall have been presented to the town clerk, nor shall any such sum or sums of money be considered payable to the contractor until the expiration of 14 days after such certificate shall have been so presented; nor shall any omission to pay the amount of such certificate at the time the same be payable be held or deemed to vitiate or avoid, or in any way affect the contract, but in such case the contractor shall be entitled, by way of compensation, to interest thereon at and after the rate of £5 per centum per annum for such time as such omissions shall continue. Provided always that with respect to all admitted and adjusted claims made in pursuance of the fifth section of the specification, the contractor shall be entitled to be paid in full; and with respect to any disputed or unadjusted claims made, or alleged to be made, in pursuance of such section or otherwise, the contractor shall not be entitled, before the final settlement of the contract, to any payment on account or otherwise, unless and until the engineer shall certify the correct amount of such claim or claims, nor unless and until the contractor shall give a receipt in full for and in respect of any moneys paid to him in discharge thereof. And provided also, but subject as lastly mentioned, that for the greater convenience of the parties, it shall be competent to the engineer to give to the contractor recommendations for payment on general account, in anticipation of any *primâ facie* or final certificate or of any award, as the case may be, and to the corporation and their duly authorised agent to make to the contractor any payments on general account, either in pursuance or in anticipation of such recommendations or otherwise, and to set off the same. And provided, further, that no certificate or recommendation, nor any payment on general account, shall be taken to be an admission of the due performance of the contract, or of any part thereof, or of the accuracy of any claim or demand made by the contractor; nor shall any such certificate, recommendation or payment conclude or prejudice the powers of the engineer, or the settlement of the contract, and the determination of the sum or sums or balance of money to be paid to, or received from, the contractor, nor in any other way vary or affect the contract entered into by the contractor."

Contrast that with the manner in which the engineer for a company puts it, viz.—"80 per cent. when the whole of the stuff is delivered on ground, we to keep 20 per cent. in hand until the end of three months after the engine has been tested to our satisfaction." Comment is superfluous.

Costs of Tendering and Manufacture.—The cost of tendering for electrical work is considerable, and sometimes quite out of proportion to its value. One of our largest electrical firms spent £200 in ten-

* Read before the Yorkshire College Engineering Society.

dering for the work in connection with a new station, and they did not get the work. Another well-known firm of engine makers tendered 215 times with an electrical establishment without obtaining an order. I hope they will get one before the 300 is up. One engineer, in beginning a station, asked for no fewer than 37 drawings of parts of the installation. Seeing that for every tender advertised there will be at least six firms competing, there is a great deal of wasted work when they all have to produce so many drawings. Another source of expense is that the drawings must be drawn to certain specified scales, which is quite unnecessary. In one case I remember the arrangement plan had to be drawn to a scale of $\frac{3}{16}$-inch to a foot, the other ones to $\frac{3}{4}$-inch or 1½-inch to a foot. The borough engineer, when asked if it was absolutely necessary to draw them out to these scales, said: "Oh, not at all, they were that way in the original specification, and I just copied it out again." He did not realise the time and expense in changing complicated drawings from one scale to another. Then it is quite customary to ask for a complete set of prints of every detail in the contract, occasionally in duplicate, and must be signed by the engineer before work is proceeded with; but although he signs them, he carefully states that by so doing he takes no responsibility for the correctness of the work. These men abhor responsibility. It does not seem to be the right thing, from the manufacturer's point of view, that he should scatter all over the country detail working drawings of his machinery that has been designed at great cost, and is the outcome of much experience; but it is done every day. Another request which is not liked in the drawing office is the demand for foundation arrangements a few days after the order is given out; the consequence is, that in the case of new designs, which occur very often, you have to plant the foundation bolts and trenches, and afterwards make the engines to suit. I don't see the absolute necessity for foundation arrangements before the engine house is built. In order to show the difference between electricians and ordinary beings I give this case. In one of the towns on the North-East Coast a firm of shipbuilders turn out annually about 10 large steamers, which cost approximately £29,500 each, when the engines are included. That firm I know, for a fact, does not spend £5 per annum in the drawing office for tenders. Well, in the same town a few months ago, the corporation advertised in all the leading engineering papers that "they were prepared to receive tenders for one '*steam feed pump.*'" Specification and forms of tender could be obtained from the borough electrical engineer by paying a deposit of one guinea. Tenders must be in not later than 12 o'clock noon on a certain date.

Cost of manufacture of the engines is also higher for electrical work, which will be explained when we come to that part of the subject.

Another item which runs the price up is the testing that they have to go through. The boilers have to pass an evaporative test. The engines and dynamos have to be tested all round, the feed pumps, condensing apparatus likewise are subject to a similar examination.

The following clause relating to tests is taken from a specification:—

"Each engine, alternator, and exciter to be erected and coupled together, and run continuously for 12 hours, viz, 4 hours at full load, 4 hours at three-quarter load, and 4 hours at half load, at the maker's works, in the presence and to the satisfaction of the engineer.

"The steam consumption will be taken at each of the above loads, and the average consumption of water per kilowatt-hour, measured at the terminals of the alternator, not to exceed 32 lbs. for double compound, and 28 lbs. for triple compound plants.

"The tests specified herein for temperature, conductivity, &c., will also be made.

"Independently of the above tests each engine will be exhaustively tested on the brake at full load for 12 hours.

"These tests will be repeated after erection at the central station, together with any other the engineer may deem necessary."

Now it is all very well to test an engine, but it can be overdone, and in such instances as this the cost of testing comes to a considerable percentage of the total value of the engine, especially when it is a small one. This point is often entirely ignored by the electrician, who will coolly turn round and tell you that he could buy a marine engine of equal power at a much lower figure. When an engine has to be tested on the brake for efficiency, it is no use taking the first day's figures, or even the first week's, that is if an efficiency of 90 per cent. is guaranteed; it is usually found that it takes an engine about three weeks, running night and day, before it gets up to the mark. Now there is no fault to be found in demanding a brake test. Every engine ought to be similarly tested. Weak spots are found out and put right, and the engine leaves the shop in a position to take up its full load at once without any trouble. But it has got to be paid for—that wants to be realised more by the purchasers. A plant that has to pass stringent tests must be an economical plant; an economical plant must do its work very easily, so must be a large plant; and as a large plant costs more money than a small plant, therefore an economical plant costs more than an uneconomical. It is safe to say that the price of a first-class plant is 50 per cent. more than one which could be bought to do the same work when economy and efficiency are not considered of much importance, especially in small-sized units.

(*To be continued.*)

ELECTRIC HAULAGE IN MINES.

At a recent meeting of the South African Society of Electrical Engineers, Mr. Kirkland read a paper on "Mine Haulage by Electricity," in which he stated that the load factor or ratio of the average to the maximum ordinate of a 24 hours' curve varies from 15 to 40 per cent., according to the conditions. The principal field for electric haulage on the Rand is in transporting ore from the shafts to the mill. Underground haulage is rarely necessary, for loads are small, and the main hoist can be made to do most of the horizontal transportation by judicious arrangement of the slopes.

The gauge, as a rule, is 18 inches, but at the Simmer and Jack mine it is wider, and as mills increase the tendency will be towards a wider gauge. With two motors to a locomotive, about 500 lbs. draw-bar pull may be relied upon with a starting pull of 1,000 or 1,200 lbs., and at half speed, on inclines, about 800 lbs. The locomotive should be of a weight of 5,000 lbs. Ordinary mine trucks, at 6 miles an hour, have a resistance of 25 to 30 lbs. per ton. On clean rails at Kimberley only 16 lbs. per ton was noted on well laid rails, the tangent of the slope of no acceleration being ·0078, but 25 lbs. must be assumed in general practice, so that the above locomotive could haul 20 tons in all, or 17½ tons behind itself. But with grades of 25 feet per 1,000 the resistance will be 75 lbs. per ton, and the train load will be only 6 tons. A 500-lb. pull will require 10 kw. at 6 miles per hour.

Assuming 200 tons of ore to be hauled in 10 hours a distance of, say, 2,000 feet, one locomotive could do the work on a limiting gradient of 2½ per cent. The trip load would be 6 tons, and the number of trips per day 33. We do not quite follow the figures, as there appears no allowance for the weight of the cars themselves. In a day actually about 38 trips could be got into the 10 hours. The speed being an average of six miles per hour for the return trip down grade can be done at eight miles' speed, and so allow time for switching and coupling. Mill engines using coal at 4 lbs. per I.H.P.-hour and a loss allowance of 35 per cent., shows 300 lbs. coal per day for 50 H.P.-hours. The system could be all set to work for £1,400, and should include—

One 10-kw. dynamo, with spare armature; one switchboard; two locomotives (one spare); 2,000 feet of trolley wire and 20 poles; track bonds and small wiring supplies. The annual cost of operation will be £671. This is made up as follows:—Ninety tons of coal at 16s. = £72; interest and depreciation at 12 per cent., £168; driver, £365; boy, £36; oil, &c., £30; and the total is 2 2d. per ton hauled.

Steam to do the same work would cost, says the author, £1,360 annually, including the repairs, which would be greater than with electrical plant.

The generator, while capable of continuously giving the average kw. required, and for short periods of working at 25 per cent. overload, should be sparkless up to 33⅓ overload with one and the same brush setting. It should be compound wound, and adjusted to over compound for the line loss calculated. This implies a carbon brush machine of 250 or 500 volts, as desired. If direct driven the engine should deal with a load of from 0 to 125 per cent. on a fluctuation of not over 2 or 3 per cent. Such an engine must be heavy. The locomotive should have two motors, each suspended from an axle with cut-steel gears, single reduction, running in oil. They should be of steel frame, entirely enclosed type, with carbon brushes. They should be arranged for multiple operation, only controlled by rheostat, these being preferably separate from the controlling switch and of non-arcing type, with magnetic blow-out lightning arresters: an inductance or spark coil should be fitted, and the only wooden parts should be the platform and cab.

Motor efficiency is of little importance. High efficiency demands the sacrifice of light weight and sparkless commutation. The fields must be saturated at even normal loads, so as to run at all loads free of sparking.

A well-designed motor, to run at 10 H.P. intermittently, will burn out at even 5 H.P. continuous load. Avoid, therefore, the term H.P. and rate by torque and speed, or by horse-power minutes per hour. To do the same work as an electrical locomotive will require a steam locomotive of double the weight, and cause heavy repairs. A cable system may be put in to-day, and be very much in the way a year hence. The electrical system is in all ways the best.

TECHNICAL SCHOOLS OF GERMANY.

Attention is often now directed by American journals to the technical schools of Germany. As with ourselves, America has failed to hit the mark with her own technical education simply because like ourselves she has attempted to cover too large an area. *Modern Machinery* states that German employers do not now have to pay any but skilled workers as the trade schools train up the workers. The Germans also train up the leaders, but they do not attempt to make too many leaders. The manner in which Germany is ridden by officialism so that no man can call his soul his own, is doubtless to be credited with the ability to train up each man to a definite standard and stop him short at his intellectual limit while pushing on the superior man to better things. This is so far an advantage to Germany, which neither free America nor our own still more free country can expect to have. We cannot play the drill sergeant with a whole nation, so that it behoves us to do the best we can with other methods, and we would again call attention to the lack of knowledge at the head of so many large establishments.

In one way or another the textile schools at Crefeld employ one teacher for each five students. This implies thoroughness and individual attention. At Berlin there is even a higher weaving school for the special training of managers, to which the sons of manufacturers are sent. Unfortunately too many of our own manufacturers' sons graduate on the turf, and never put in any really serious work, even in the scholastic period of life, and finally, at best, go into

their father's business with no knowledge, and with extravagant habits, their one idea being to cut down all below them to the lowest figure at which existence is possible. Then comes flotation, next re-construction, and finally voluntary liquidation of an old-established business. There is really no reason why an old-established business need die out. With fresh men given an interest in the concern, and a man at the head with brains enough to pull down and rebuild every few years, why need a concern get old. It is the old buildings and the fearful complication of machinery, especially in power transmission, and the loss due to the years of patchwork and bad arrangement of passages and buildings, and the accumulated dirt and rubbish which bring a place to a standstill.

Now with central stations for power, every machine can carry its own motive power, and at once disappears the need of heavy walls and pillars for mere shaft carrying. Electrical transmission should cheapen building, and reduce the fear of reconstruction. In America, says *Modern Machinery*, nothing kills a man so quickly as having theories. He is looked on as unpractical. This is different in Germany. A man with theories is all right there, and usually he finds men of means capable of grasping his theory and helping to put it into commercial shape. There are millions sterling standing idle in England because its possessors have not the ability to see if a theory be sound or not. Never will the present writer forget how a steam user argued against the covering of his engine steam pipes, on the ground that they passed through the stove, and the stove had to be heated somehow, why not with this large and convenient pipe? He simply declined to accept any argument about the wasteful action of wet steam, and he must have been burning 7 lbs. of coal per H.P.-hour. These men are as common as cabbage butterflies, and their ideas are about as valuable.

What astonishes us is the enormous margins for economy which exist all about us, and the impossibility of getting men to see them. Germany would not be in it with England if we would only pick up the loose threads.

ACCUMULATOR TRACTION.*

At a meeting of the Société des Ingeniéurs Civils de France, held on July 22nd, M. F. Drouin read his paper on "The Electric Traction of Tramways by Rapid Charge Accumulators." M. F. Drouin described the system of traction by accumulators employed on the three lines of the Madeleine.

This installation, established in 1896 by the Société Industrielle des Moteurs Electriques et à Vapeur, differs from the systems employed hitherto in the fact that the charging is effected very rapidly at the termini while the cars are stationary.

Before describing it in detail, M. Drouin spoke of the mixed trolley and accumulator system which has led to the realisation of rapid charging batteries. The tramways of Hanover, Dresden, &c., work under these conditions. A series of comparative tests, made by Mr. Ross, has shown that this system gives very satisfactory results.

This mode of traction could not be applied to the lines of the Madeleine, as the trolley had not been sanctioned there. Moreover the ordinary system worked by removable batteries could not be employed, as three stations or sub-stations would have been required for charging, and for the manipulation of the batteries. A system has been adopted which enables the cars to be charged on the track during the few minutes that they stop at the terminus. The trying conditions to which the accumulator is subjected during this rapid charge necessitates certain arrangements which, in the Tudor accumulator, are as follows:—

1. The use of electrodes with a very large surface.
2. Charging at a constant voltage and the utilisation of part only of the maximum capacity of the battery.

The cars used weigh, when charged, 14 French tons, 3,600 kilogrammes of which are accumulators. The battery consists of 200 elements arranged under the seats. A small board enables the battery to be put into communication either with the discharging or the charging circuit; the latter includes two flexible cables which unite at one of the charging terminals, communicating with the station by means of underground feeders. The charging tension is 600 volts. The station is situated on the Quai National, at Puteaux, and comprises three distributing groups of 120 kilowatts. After having shown various views of cars and of the station, M. Drouin concluded with a *résumé* of experiments undertaken with a view to determining the resistance of the cars to the traction.

By these it is shown that on level ground and along a straight line this resistance, including that of the motor turning without load, may be represented between 5 and 25 kg. by the formula,

$$R = 3 + 0.16\,v,$$

R being expressed in kg. per ton, and v in kilometres per hour.

The resistance R′ of the car alone is:

$$R' = 0.94\,R.$$

Some experiments were made on curves. The results vary considerably, according to the state of the rails, &c.; at 10 kilometres per hour and on a curve 40 to 45 metres, the resistance amounts to about 25 kg. per ton.

The president thanked M. Drouin for his very interesting and complete paper.—*L'Electricien.*

* We briefly referred to this subject in our issue of September 23rd, in a leading article dealing with the experiments of Messrs. Cahen and Donaldson in charging secondary batteries.—Eds, Elec. Rev.

EXPERIMENTS WITH BLAST FURNACE GAS.

Following in the footsteps of Mr. B. H. Thwaite, the Cockerill Company, of Seraing, have been experimenting with blast furnace gas for motive power purposes.

The furnaces use coke as fuel, and the experiments were made to determine the consumption of gas, oil, water for the jackets, and gas washing under normal working conditions. The Cockerill Company were already aware of what had been done in England by Mr. Thwaite, and they placed these experimental trials in the hands of the well-known expert, M. Aimé Witz, who has submitted his findings in a paper to the Iron and Steel Institute.

The trial was of 24 hours' duration, the power 200 effective H.P., being developed with about 90 per cent. of admissions. The engine was of the Simplex type of Delamare-Debouttville et Malandin, and was of 800 mm. cylinder diameter, 1·00 m. stroke, 105 revs. per minute, and 7·5 kilos compression per cm². The gas came from four blast furnaces either directly or through a holder of 300 m. capacity. A brake was used to measure power with a cooled pulley of 1·546 m. diam. = 4·857 m. circumference, with a weight table and spring balance to the rope. Counters were fitted to count revolutions and explosions, and the customary measurements and temperature corrections for gas volume were made. The results showed that for each effective or brake horse-power generated, about 124 cubic feet of gas (3½ m³) were consumed per hour. This figure may be compared with that obtained in 1896 with Mr. Thwaite's plant at Wishaw by Mr. W. H. Booth, who found a gas consumption of about 124 cubic feet, when corrected for temperature, for each electrical horse-power. M. Witz also finds a consumption of 100 litres of water per horse-power hour in the jackets, and less than 18 grammes of oil and grease, and he finds none of that trouble from dust which a German professor stated would prevent the working of the gas in engines, although the said professor, had, we believe, been informed that no trouble had arisen in many months of actual work at Wishaw.

The trials of M. Witz took place in July, 1898, and the mean results were 105·20 revolutions per minute, 1,595·45 average brake load, 181·16 average effective horse-power, 47 admissions of gas per minute, or 89·3 per cent. of maximum possible; efficiency 85 per cent.; temperature of atmosphere 17·5°, of gas 21°, of exhaust 480° to 510°, of water at entry 22·7°, at discharge 33·7°; barometer 765 to 777 mm.

The analysis of the gas is not given, but it is remarkable as a possible indication of the comparative uniformity of blast furnace gases that the consumption per horse-power-hour should be so similar for this large engine and the smaller engine at Wishaw. Practically the smaller engine was the more economical apparently, but the figure above given was a minimum observation, a maximum being 139 cubic feet, or a mean of probably 132 feet per electrical horse-power output, as against 124 feet for the Simplex engines' brake output. Obviously the brake output is always higher than the electrical output of a belt-driven dynamo, so that the coincidence is remarkable, seeing that at Wishaw coal is the fuel and at Seraing the fuel was coke.

There can be no possible doubt remaining as to the value of blast furnace gas for motive power purposes. The wonder is that iron masters, pressed by the United States competition, do not set themselves to the task of utilising this, the main bye-product of their furnaces. They might reasonably commence by abolishing their boilers and driving their blowing engines by a belt on the fly-wheel from a gas engine, and the electrical transmission of the remainder of the power would quickly follow.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

HYDROMETERS OF TOTAL IMMERSION.

By A. W. Warrington, M.Sc.

Abstract of Paper read before Section A.

The writer has made a series of experiments with the object of showing that the hydrometer becomes an instrument of scientific precision if it is modified, so that when used it is totally immersed in the liquid.

By slipping small ring-shaped platinum weights over the stem, the specific gravity of the hydrometer can be made to approximate to that of the liquid under examination. If the hydrometer be now placed in the liquid and the temperature of the latter be allowed to change *very* slowly, and means are adopted to prevent convection currents, a point is reached at which no difference can be detected between the specific gravity of the liquid and of the hydrometer, or two points, differing only by a few thousandths of a degree, are determined, at one of which the hydrometer is lighter and at the other heavier than the liquid.

By allowing the final slight adjustment of temperature to take place with extreme slowness and by frequent and effectual stirring, it was believed that the prejudicial influence of convection currents would be reduced to a negligible minimum. Perhaps the best possible proof of the absence of convection currents was furnished by the hydrometer itself, which often for minutes remained poised in the middle of the liquid.

The determination of the exact temperature at which the specific gravities of the hydrometer and of the liquid are the same is neither

so lengthy nor tedious a process as one might at first imagine. The time taken will depend upon the experience of the operator and the means employed for altering the temperature.

The proposed method is only designed for determinations in which great accuracy is desired. The specific gravity of the liquid should be known approximately. The temperature to the nearest degree should then be calculated and a preliminary observation made to find it to the nearest tenth. The temperature is then allowed to fall a little, and the final observation made with the temperature rising at the rate of about one-tenth of a degree Centigrade in an hour. Owing to the high specific gravity of platinum the increase in the volume of the hydrometer caused by the platinum added can be calculated with sufficient accuracy.

The hydrometer is to all intents and purposes a huge specific gravity drop, the weight of which can be altered at will and the volume of which at any particular temperature can be determined by an experiment in water.

The advantages claimed for this method are:—

1. That it is exceedingly sensitive. The probable error of an observation made on the same day with the hydrometer loaded with the same weight was equivalent to a change of density in water of 4 in 10,000,000.

2. The weighings are made under the most favourable conditions. Indeed, it is possible to so accurately determine the relative values of the platinum ring-weights as practically to eliminate this source of error.

3. The method is applicable within a considerable range of temperature without appreciable change in accuracy. The writer's experiments ranged from 0° to 40° C.

4. Many sources of error present in other methods are eliminated without the introduction of new ones.

To determine the specific gravity of a solid use is made of a hydrometer in form not unlike a Nicholson hydrometer which has lost its tray.

If P grammes of mercury, weighed in vacuo, are required to bring the hydrometer to the same specific gravity as water at $t°$; and if the sum of W grammes of the solid and P_1 grammes of mercury, both weighed in vacuo, are required to bring the hydrometer to the same specific gravity as water at $t°$.

Then, $$W = \frac{S\,W}{Q} = (P - P_1) - \frac{S\,(P - P_1)}{M}$$

In which S = the specific gravity at $t°$ of water,
M = " " " mercury,
and Q = " " " the solid.

In practice, of course, the temperature will never be identical in both experiments. If, however, they are within a few tenths of a degree the value of P for the required temperature may be calculated. For the volumes and coefficients of cubical expansion of the hydrometer and of the mercury are known.

To obtain and maintain the required temperature the experiments were performed in an incubator, the roof of which was perforated with holes to admit of the thermometer, the connecting rods of the stirrer and a contrivance to clamp the hydrometer while stirring.

With a hydrometer of about 162 c.c capacity the probable error of a determination of the specific gravity of a liquid is 1 in 1,000,000. Experimenting with the Nicholson variety on the specific gravity of a piece of pure quartz weighing about 32 grammes, the writer found the probable error of a determination to be 1 in 100,000.

ELECTRIC TRACTION BY SURFACE CONTACTS.

By S. P. Thompson and Miles Walker.

Read in Section G, September 12th.

Surface contacts are of interest at the present time because local authorities object to trolley wires; tramway companies do not like the expense of conduits with open slots, and everyone is disgusted with the weight and rapid deterioration of accumulator cells. The only other approved method of supplying a tramcar with electric power is by means of surface contacts, and with regard to these people are asking for information.

One of the pioneers in surface contact electric traction was the late Dr. John Hopkinson. In a patent specification filed in 1882 he

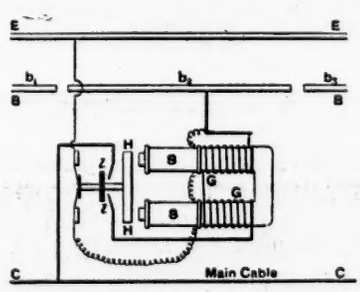


Fig. 1.—Dr. John Hopkinson's Method, 1882.

was the first to describe all the essential features of electro-magnetic mechanism for successively connecting section of conductor to a supply main. The object in view at that time was the prevention of the serious leakage which would occur from a long insulated rail. The device that he proposed is shown in fig. 1. The insulated rail, B, is cut up into section b_1, b_2, b_3. Each of these can be connected with a supply cable, C, through the switch points, *l l*. The switch is operated in the following way:—Suppose a car to be running on the rails picking up current from the section b_1, and putting it down to the return rail, E E. As soon as one of the collecting brushes comes in contact with the section b_2, current passes round the shunt coils, S S, of the electro-magnet, and to the return rail, E E. This raises the armature, H, and completes the circuit from the cable, C, through *l l*, and through G G, the series coils of the electro-magnet to the section b_2. At the same time the shunt circuit is broken, the electro-magnet being now excited only by the main current passing through G G. Thus the car can pass over section b_2, and as soon as it leaves it the current no longer flows through G G, so that the armature drops, and the section, b_2, is cut out. It will be noted that the primary object of the invention was to enable B to be cut up into sections, so as to diminish the leakage which would occur on a very long line. It was not intended to expose a high voltage rail in a public thoroughfare, so no special precautions were necessary to ensure the absolute reliability of the switches. A year earlier Ayrton and Perry had suggested mechanical and electrical means for affecting the same object, and in 1883 they filed a second specification, giving a most

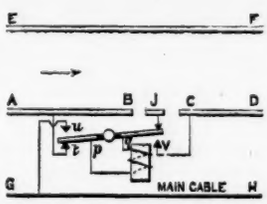


Fig. 2.—One of Ayrton and Perry's Methods, 1883.

complete and lucid account of various ways of connecting up electro-magnetic switches and various forms of magnet available for the same. It would take too long to give the substance of the 31 drawings of this specification, but it is of interest to notice one of them.

In fig. 2 the sections of the rail are A B, J and C D, E F is the return rail, G H is the supply cable. The switch lever, when not operated upon by the electro-magnet, rests in the position shown. The locomotive is intended to run in the direction indicated in the arrow. Assuming that the section A B is "alive" when the locomotive reaches J, the main current passes by the contact point, *t*, through the electro-magnet by *p* and *q*, and the lever is rocked over making contact between *u* and *v*, and thus connecting C D to the main. It will be noticed that this method differs from Hopkinson's in so far that it is the main current on its way to the car locomotive that first operates the switch. There are really two functions to be performed by the coils of the electro-magnet: (1) the switch must be in the first place closed, and then (2) kept closed while the car is running over the section. In Hopkinson's switch the two functions are carried out by a shunt coil and a series coil respectively. Fig. 2 shows the first published method of operating the switch by means of the main current. Ayrton and Perry also employed shunt coils as operating coils, and suggested the use of a magnet carried on the car to perform the same function. Indeed, so wide and varied are the descriptions in their specifications, that they cover much of the ground of inventors who came after them.

So far, the main object in view had been the prevention of leakage from a long line, or the automatic blocking of trains by cutting off the supply of electricity from any second train that might run upon an occupied section. But the demand for some system of picking up current without employing a trolley wire or open slot in the road led inventors to try this method of surface contacts for ordinary

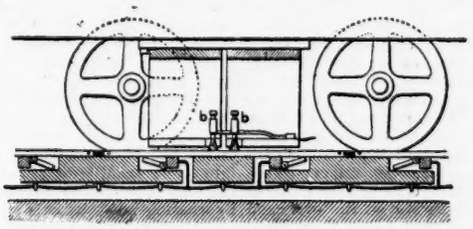


Fig 3.—Pollak and Binswanger, 1886.

streets. In 1886 Wynne devised a system in which the contacts were short pieces laid in the road, and connected successively to the main feeder by means of a little trolley that ran in a closed tunnel under the roadway. Then Pollak and Binswanger, developing a suggestion which had been thrown out by Ayrton and Perry, describes a method of operating the switches by means of a magnet carried on the car. Fig. 3 shows their specification drawing, which certainly has the air of simplicity. In connection with this system, it may be well to mention at once Diatto's more recent experiments. Diatto employs an electro-magnet (fig. 4) consisting of a number of cylindrical magnets, M M, with their similar poles riveted into a long strip of steel, P, thus making up a long polar face, which is suspended from

the car and extends along its length. This pole comes in contact with an iron peg, F, fixed in each road contact, and magnetises it, so that it attracts a movable iron peg, G, floating in mercury, H, and connected to the main, C. Thus connection is made between road contact and the main. Diatto has worked out successfully all the practical details of his system on a line in Italy.

There is no doubt that systems based upon this principle have one great advantage over many other systems. The force tending

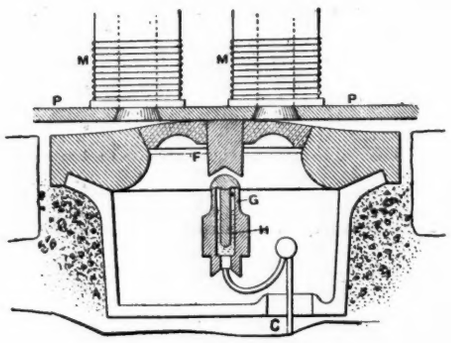


Fig. 4.—Diatto, 1894.

to keep the switch closed can only operate when the car is over the switch. If the contact points of the switch can be made so that they will never stick together, then so far as the safety of the public is concerned, there is no better system than this direct magnetic-pick system. It is, however, to be doubted whether in the small space available under an ordinary electric car there is sufficient room to place a long electro-magnet which will operate really reliable switches. The difficulty is increased when going at full speed or round sharp curves. Some methods which are allied to the above are those described in the specifications of Lineff. Fig. 5 illus-

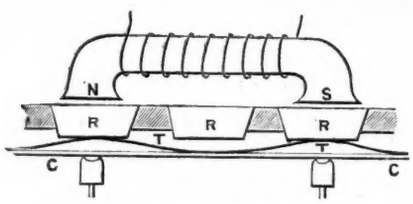


Fig. 5.—Lineff, 1888.

trates an early type. An iron or steel strip lies in contact with the insulated main conductor; immediately over it are the surface studs. A magnet on the car attracts the strip upwards so that it comes in contact with the surface studs, thus connecting them with the main. As the car moves forward the wave in the strip moves forward like the sinus in the back of the mythical serpent. The method is as ingenious as it is simple, but there must always be a difficulty in making in this fashion a reliable contact with the surface studs.

The feebleness of the effect under the roadway of a magnet carried on the car has led many inventors to prefer an electric method of communicating with the switch, after the manner of Hopkinson and Ayrton and Perry. Very many different methods of operating the switches electrically have been devised. They fall into three classes: (1) Those in which the operating coil is a shunt to the motor circuit; (2) those in which it is in series with the motor; and (3) those in which it is excited by a battery carried on the car. Each method has its advantages and disadvantages. The main objection to a shunt coil is its cost. It may further be open to the objection that a very small leak in the insulation of the main may be sufficient to keep it in operation when it ought not to be. On the other hand, it has points of advantage over a series coil. As it always exercises the same pull it can be designed to a nicety to do the work required of it, and, in general, can be put into a very small space; whereas a series coil is dependent in its action upon the current taken by the car, and while on the one hand its winding must be able to carry 100 amperes for a short time, it must have enough turns in it to operate the switch when only carrying two or three amperes. This necessitates a bulky winding, which increases the size of the switch and its box. Besides this, the force operating the switch is apt to be too violent with large currents, or too feeble with small currents. The great advantage of the series coil has always been that by its use the operation of the switch could be made more dependent upon the presence of the car. If the car is not over the surface contact it cannot draw current from it, and it might be argued that the series coil would then of necessity have no current through it. This would afford abundant safety to street passengers, if it were not for the fact that some current may be leaking from the road contact to mud in street, and this may be sufficient to keep the switch closed. To illustrate this, let us take a very old design of Frank Wynne's. The view (fig. 6) is, of course, diagrammatic. The car is intended to run in the direction indicated by the arrow. When switch No. 2 is closed, current can flow from the main cable by means of the armature, A, through the

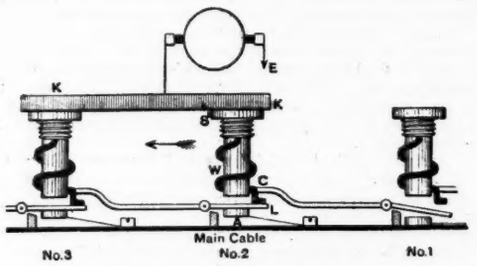


Fig. 6.—Wynne, 1887.

level, L, to the contact, C, from thence it passes round the winding of the magnet, W, to a stud, S, laid in the road. In contact with the stud, S, is a long metal skate, K K, carried on the car. The current passes to this, and on through the motor to earth. As soon as K K comes in contact with stud No. 3, the current divides part of it, going through the winding of switch No. 3 and operating it. Stud No. 1 is shown disconnected, the switch having opened when the skate left its stud; but it is easy to see that if current could leak from stud No. 1 to earth there would be some current in the coil to keep the switch closed. Many devices have been suggested to remedy this defect. Mr. Wynne himself has proposed numerous methods. In a recent design carried out in conjunction with Mr. David Urquhart, the current which operates the switch is an alternating current flowing into and out of a condenser. The continuous current which works the car cannot go through the magnet winding, because it cannot get through the condenser. The methods suggested by some inventors are exceedingly complex, their diagrams being perfect mazes of connections and interconnections; the number of studs and skates being increased to an alarming extent. One of the simplest arrangements is that of Johnson and Lundell. They adopted a method which was originally suggested in Germany, and consisted in operating the switches by the current on its way from the car to earth instead of on its way from the main to the car. Fig. 7 shows one of

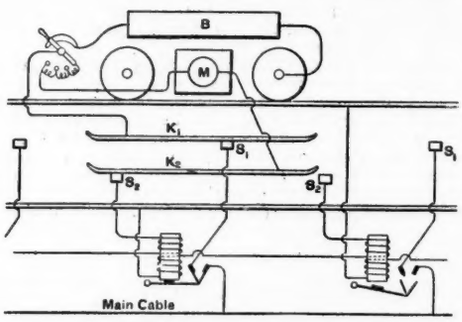


Fig. 7.—Johnson-Lundell, 1896.

their diagrams. It will be seen that the current passes from the main cable through the switch direct to the stud marked S_1 without passing through any magnet winding, thence it passes to the motor by means of skate K_1. From the motor, instead of going direct to earth, it passes to skate K_2, thence to S_2, and so through the magnet windings to earth. Now the stud, S_2, is at very nearly the same potential as the earth return, so that the question of leakage from it does not trouble us. By placing S_2 outside the rails it can be effectually guarded against stray currents from S_1. One feature in this design is the interconnection of the switches whereby a switch is operated before it is required to supply current to the car. This gives greater time for the switch to close.

(To be continued.)

THE ELECTRO-THERMAL PROCESS FOR THE MANUFACTURE OF PHOSPHORUS.

By JOHN B. C. KERSHAW, F.I.C.

Historical Notes.

Phosphorus was first prepared by Brand, a German alchemist, in the year 1674, by heating urine and white sand in an earthenware retort. The method of preparation

was kept secret, but the English chemist, Robert Boyle, having heard of the new element and its source, succeeded in preparing it by a similar method in 1680. The element was only prepared in very small quantity, and was of very high cost until 1771, when Scheele published his method of obtaining it from bone ash. Scheele's method was later simplified by Pelletier, and this modified method of manufacture has been used for the production of all the phosphorus required in the laboratory or for industrial operations from the time of Scheele down to the year 1893.

The process is purely chemical in character. Bone ash or some other form of phosphates being digested with sulphuric acid, and the clear solution evaporated to a thick syrup and then heated with carbon in closed retorts. The only improvement upon the original process has been the substitution of "Somberite," a natural phosphate occurring in the West Indies, for bone ash. The production of phosphorus by this method has, owing to the growth of the match-making industry, greatly increased during the latter half of the century; and in the year 1893, when the electro-thermal method was first worked upon an industrial scale, it was estimated that the total production was about 1,200 tons per annum. This output was almost entirely the result of the operations of two firms, Messrs. Albright and Wilson, of Oldbury, and MM. Cognet et Fils, of Lyons.

The former now use the Electro-thermal process, and since the change in their method of manufacture have been rapidly increasing their annual output of phosphorus; while MM. Cognet et Fils, who still use the older chemical process, have fallen to the rear as producers, and have ceased to export phosphorus to other countries.

The Electro-Thermal Method of Phosphorus Production.

The Readman-Parker process, which is in use at the Oldbury and Niagara works of Messrs. Albright & Wilson, was patented in this country in the year 1888. (Patent Nos. 14,962 and 17,719.) The method consists in heating natural phosphates, intimately mixed with carbon and suitable fluxing materials, in the electric furnace, by means of an electric current passing between carbon poles. The heating is due to the resistance of the materials, and not to the formation of an electric arc, as in Moissan's experimental work. The furnaces are small, and are capable of yielding 1½ cwt. phosphorus per day. Each is provided with a hopper for continuous feeding in of the raw materials, with an outlet for the slag, which is tapped from time to time, and with a gas outlet placed high in the side of the furnace for conducting the vaporised phosphorus to the condensers. Between 80 and 90 per cent. of the phosphorus contained in the raw materials is obtained by use of this process. The Oldbury works absorb 700 H.P. in this manufacture, and the recently erected works of the same firm at Niagara are now utilising 300 H.P. derived from the Falls in the production of phosphorus, while an increase of the plant at Niagara is already contemplated.

In Germany, an electro-thermal process for the manufacture of phosphorus is used by the Greisheim works, near Frankfort, but no details are known concerning it, and this firm objects to give any information concerning its operations. There is no doubt, however, that the process is practically the same as that described above, and, owing to the German Patent Office having refused a patent to Readman on the ground of previous publication of the principles of the method by Wohler, the electro-thermal method of phosphorus manufacture in Germany is freely open to all who desire to adopt it.

It is interesting to note that this manufacture is a new one for Germany, and that, until the Greisheim firm took up the manufacture, that country was dependent upon England and France for covering her requirements of phosphorus.

A phosphorus factory using an electro-thermal process, has also been recently erected at Vernier, near Geneva; and here again it is probable that the process is practically the same as that of Readman & Parker, though no details have yet been published concerning it.

The electro-thermal method of manufacture is thus now established in four countries, and there is no doubt in the writer's mind that the process will ultimately extend to the two countries where the older method is still in use—France and Russia—and that before the century closes, the method introduced by Scheele in the year 1771 will have been supplanted everywhere by the electro-thermal method of production. It is possible that improvements may be made in its mode of application—as, for example, in the manner suggested by Joudrain in a recent patent covering the simultaneous production of phosphorus and calcium carbide—but the principle of the process will undoubtedly remain the same. The advantages claimed for the electro-thermal method are that no sulphuric acid is required, no expenditure upon fire-clay retorts and replacement of broken ones is necessary, less handling of the raw material is demanded, and the risk of fire is minimised. The economies resulting from all of these more than balance the expenditure upon electrical energy.

The Future of the Industry.

As already stated, the greater portion of the phosphorus at present produced in Europe and America is used in the manufacture of matches. Attention has recently been directed to the evils attendant upon the use of yellow phosphorus in this industry, owing to the non-notification of several cases of phosphorus poisoning—or "phossy jaw"—by one of the leading match-making firms of the country. This disease occurs only when the yellow or crystalline form of phosphorus is used, and cannot occur with that known as red or amorphous phosphorus. Unfortunately this form of phosphorus can alone be used for the production of safety matches, *i.e.*, matches striking only on the box, and the public demand a match which will strike on any roughened surface. This latter can only be manufactured at present with the aid of yellow phosphorus. Many attempts have been made in the past to find a substitute for yellow phosphorus in this manufacture without success; but renewed attention is now being paid to the subject, and the Belgian Government has recently offered a very large money prize to any inventor or chemist who can produce a match striking on any surface at reasonable cost, without the aid of the dangerous chemical hitherto used. The writer has also recently learnt that such matches are already being produced in France in large quantities, though he has not been able to obtain any details of the composition used. It is thus evident that the phosphorus industry must be at present in a very unsettled state. Should a satisfactory and economical substitute for this chemical in the match-making industry be discovered, the demand for phosphorus will be enormously curtailed, and the production of phosphorus by the electro-thermal method will become of secondary importance when compared with other electro-chemical industries.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

19,803. "Improvements in and connected with the manufacture of filaments for electric lamps." J. B. de Alzugaray. Dated September 19th.

19,824. "Improvements in means or apparatus for facilitating calculations relating to secondary electrical batteries." M. B. Cotterell. Dated September 19th.

19,827. "Improvements in electric arc lamps." B. H. Pomeroy. Dated September 19th.

19,828. "Improvements in electric arc lamps." B. H. Pomeroy. Dated September 19th.

19,829. "Improvements in coin controlled meters." B. H. Pomeroy. Dated September 19th.

19,843. "Improvements in insulating bodies." C. Noltemeier. Dated September 19th. (*Complete.*)

19,855. "Improvements in the manufacture of electrodes for electric accumulators." H. H. Lake. (La Societe Roger & Rathier, France.) Dated September 19th. (*Complete.*)

19,856. "Return signal device for electric bells and the like." W. P. Thompson. (Firm of Ohl Dieterich, Germany.) Dated September 19th.

19,875. "Improved joint for telegraph and other wires conveying electricity." H. W. Neild. Dated September 19th.

19,876. "Improvements in the electrolytic separation of zinc from zinc oxide." O. J. Steinhart, J. L. F. Vogel, and H. E. Fry. Dated September 19th.

19,877. "An improved cell for the electrolysis of fused metallic chlorides." O. J. Steinhart, J. L. F. Vogel, and H. E. Fry. Dated September 19th.

19,911. "Electric door lock for opening doors and gates at a distance." O. Melville. Dated September 20th.

19,913. "Improvements in arc lamps." W. G. Heys. (The Manhattan General Construction Company, United States.) Dated September 20th. (*Complete.*)

19,936. "Improvements in controllers for electric motors." The British Thomson-Houston Company, Limited. (F. E. Case, United States.) Dated September 20th. (*Complete.*)

19,937. "Improvements in or relating to electric braking apparatus adapted specially for use in electric tramways." The British Thomson-Houston Company, Limited. (J. B. Linn, United States.) Dated September 20th. (*Complete.*)

19,938. "Improvements in safety devices for dynamo-electric machines." The British Thomson-Houston Company, Limited. (E. M. Hewlett, United States.) Dated September 20th. (*Complete.*)

19,939. "Improvements in electric meters." The British Thomson-Houston Company, Limited. (C. D. Haskins, United States.) Dated September 20th. (*Complete.*)

19,940. "Improvements in circuit breakers for three-wire electricity distribution systems." The British Thomson-Houston Company, Limited. (E. M. Hewlett, United States.) Dated September 20th. (*Complete.*)

19,941. "Improvements in electrostatic measuring instruments." The British Thomson-Houston Company, Limited. (E. Thomson, United States.) Dated September 20th. (*Complete.*)

19,942. "Electric engines." B. J. B. Mills. (M. L. Whitfield and C. C. Cowan, United States.) Dated September 20th. (*Complete*)

19,951. "Improvements in electrical gas lighters." E. Seiler. Dated September 20th. (*Complete.*)

19,959. "Improvements in systems of electrical distribution." C. F. Scott. Dated September 20th.

19,960. "Improvements in or relating to electric railways." R. Belfield. (The Foreign Electric Traction Company, United States.) Dated September 20th.

19,972. "A switch worked by clockwork, or by electricity, or both, or by hand independently of either." J. Hooper. Dated September 20th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 9th, 1898, being date of application in Natal.) (*Complete.*)

19,974. "Improved carbon filaments for electric incandescent lamps." F. Dannert. Dated September 20th. (*Complete.*)

19,983. "Improvements in search light projectors for electric arc lamps." T. Duckitt and J. I. Hall. Dated September 21st.

19,985. "An improved incandescent electric light lamp holder." A. Howell. Dated September 21st.

20,008. "Improvements in the manufacture of metallic covers for electrical switches, cut-outs, and the like." M. Lawton. Dated September 21st.

20,027. "Improvements in electrical apparatus for exhibiting and changing advertisements, signs, and the like devices." A. D. Douglas. Dated September 21st.

20,029. "Improvements in electric batteries." W. S. Rawson. Dated September 21st.

20,049. "Improvements in electric safety fuses." W. L. Wise. (The Actien Gesellschaft Electricitaetswerke—worm O. L. Kummer and Co.—Germany.) Dated September 21st. (*Complete.*)

20,068. "Improvements in electric arc lamps." H. G. Cotsworth. Dated September 22nd.

20,131. "Improvements in automatic switches for railways." J. L. Calame and V. Beffa. Dated September 23rd.

20,154. "An improved form of electrical resistance." F. H. Royce and E. A. Claremont. Dated September 2r3d. (*Complete.*)

20,178. "Improvements in or relating to switches for controlling electrical currents." J. Booth. Dated September 23rd.

20,193. "Improvements relating to switches for tramways." V. Demerbe. Dated September 23rd. (*Complete.*)

20,202. "Improvements in electrical apparatus for operating railway points and signals." T. Ducousso. Dated September 23rd. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 24th, 1898, being date of application in France.) (*Complete.*)

20,208. "An electrical alarm to warn two vehicles approaching each other upon rails." F. Pegelow. Dated September 23rd. (*Complete.*)

20,221. "Improvements in the means or method of signalling on electric tramways." J. Kay and A. H. Gibbings. Dated September 23rd.

20,227. "Improvements in electric lamp holders." A. Watson. Dated September 24th.

20,274. "Improvements in systems of controlling electrically propelled railway trains." F. E. Case. Dated September 24th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 28th, 1898, being date of application in United States.) (*Complete.*)

20,275. "Improvements in controlling electric motors and electrically-propelled railway trains." E. Thomson. Dated September 24th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 28th, 1898, being date of application in United States.) (*Complete.*)

20,276. "Improvements in systems of train control for electrically-propelled vehicles." W. B. Potter. Dated September 24th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 28th, 1898, being date of application in United States.) (*Complete.*)

ELECTRICAL PATENTS OF 1884, EXPIRING IN OCTOBER, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 86 applications for electrical patents were filed in the month of October, 1884. Out of these applications some were never completed, and of those that were not one has been allowed to run its full length of term, viz , 14 years, but became void after a period of a few years.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free*, 9*d.* (*in stamps*).

10,477. "Improvements in quick-break switches for electric lines." G. Jaeger, C. Jaeger, and H. Bender. Dated April 30th, 1898. This invention has reference to improvements in quick-break switches for electric lines of that class known as "tumbler switches." According to the present invention the switch consists in that the terminals are embedded in the insulating body, that is to say, the terminals are surrounded entirely within the latter by means of an insulating wall, being semi-circular or the like and extending upward. Between the two terminals joining with the wall, a partition is fitted, being of such a thickness as to afford sufficient play to the outer ends of the contact lever while snapping between the partition and the terminals. 1 claim.

10,606. "An electric signal bell for cycles." S. Kraus. Dated May 9th, 1898. Relates to a cycle bell brought into action by the closing of an electric circuit. In the steering frame is arranged a battery; it is enclosed in an insulation casing against which the insulated conductor from the lower pole lies close. The insulated conductor is further carried along the interior of the steering bar and is connected to the inner end of the metallic push. The push button is arranged with its inwardly projecting pin like projections in a vulcanite shell, which is held by friction. On pressing down the button a spring is compressed until the edge and the steering make contact; the circuit is completed through the bell. 1 claim.

10,652. "Improvements in electric condensers." C. S. Bradley. Dated May 10th, 1898. Relates to electric condensers, the object being to provide a condenser of a greatly increased capacity, bulk for bulk as comparted with the condensers as commonly organised. The invention is carried out by using as a dielectric stearate of lead which has a specific inductive capacity much greater than paraffin wax or other material. Pure stearate of lead free from water and deleterious mixtures has a specific inductive of 74 to one as compared with air and offers a great resistance to puncture. This material may be used in any convenient way for separating the several condenser plates. In order to reduce the compass of the condenser as much as possible, it is desirable to employ thin films of the dielectric, it is important also to prevent short-circuiting by contact of opposite plates. This end is attained by using between the several plates sheets of open-work fabric. The dielectric being rolled into the meshes of the netting and over the same to the desired thickness either before or after applying the same to the plate. 7 claims.

10,808. "Improvements in Morse telegraph apparatus." Siemens Bros. & Co., Ltd. Dated May 11th, 1898. This invention is to prevent ink from getting into and dirtying the mechanism. The spindle of the writing disc is enclosed in a tube extending across the casing. (The gearing for imparting rotary motion to the spindle is arranged outside the casing.) Any ink that tends to creep along the spindle is intercepted by a cup-shaped shield, which causes the ink to drop back into the reservoir. 3 claims.

11,860. "An improved means for making and breaking electric circuits." A. Sauerbrey. Dated May 25th, 1898. In this invention the electric circuit is made by the meeting of two or more contacts with different or like resistances, and actuated from batteries or other sources of electricity and a relay. It consists of two magnet bobbins of a relay the bobbins at one end being connected through a bridge wire, the opposite ends of the same being connected with the batteries from which the wires lead through circuit closers or cut-outs to the contacts, and from these to the bridge wire. In the above arrangement if the circuit closer is closed the current flows through the battery onward through magnet bobbin to the bridge and a contact and again into the circuit closer, whereupon the magnet is energised and attracts an armature. The contact devices are fixed to a spring and a platinum screw, connected with a resistance of determined dimensions. The screw upon the occurrence of any shock to, or movement of its stand, and other parts in connection therewith comes into operation and thereby actuates a suitable signalling device. 2 claims.